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MICHIGAN STATE COLLEGE
AGRICULTURAL EXPERIMENT STATION
EAST LANSING

THE QUARTERLY BULLETIN

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THE QUARTERLY BULLETIN

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MICHIGAN STATE COLLEGE
AGRICULTURAL EXPERIMENT STATION
EAST LANSING

C. M. HARDIN, DIRECTOR
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INHIBITION OF SPROUTING AND REDUCTION OF STORAGE LOSSES IN ONIONS, POTATOES, SUGAR BEETS, AND VEGETABLE ROOT CROPS BY SPRAYING PLANTS IN THE FIELD WITH MALEIC HYDRAZIDE

By S. H. WITTWER and D. R. PATERSON
DEPARTMENT OF HORTICULTURE

SPECTACULAR results with a new growth regulator, maleic hydrazide (2), have been obtained in controlling sprouting, prolonging the storage life, and decreasing storage losses in onions (3), potatoes (1), sugar beets (5), and certain vegetable root crops (4). The effective treatment consists of a single preharvest spray of maleic hydrazide[1] to the leaves of the growing plants. Water solutions of 500 to 2500 parts per million (p. p. m.) of the chemical are used with a wetting agent. Details of the treatment and some results obtained follow for each crop.

ONIONS

A preharvest foliage spray of maleic hydrazide has completely eliminated sprouting of onions in storage for all major varieties grown in Michigan. Even at the relatively high temperatures which exist in storages during the late spring and summer, the bulbs have remained completely dormant. If planted, they produce neither roots nor sprouts. During two years of study, no effect of maleic hydrazide has been observed on flavor, color, odor or general appearance of the onions. Field tests show no reduction in yield following treatment. With the absence of sprouting, bulbs in storage have remained firm several months longer than non-treated lots (Fig. 1).

An interesting aspect of the use of maleic hydrazide in the keeping quality of onions is its possible significance in the national onion-breeding program. Recently, much attention has been directed toward

[1]Formulated as the diethanolamine salt of 1,2 dihydro 3,6 pyridazinedione.

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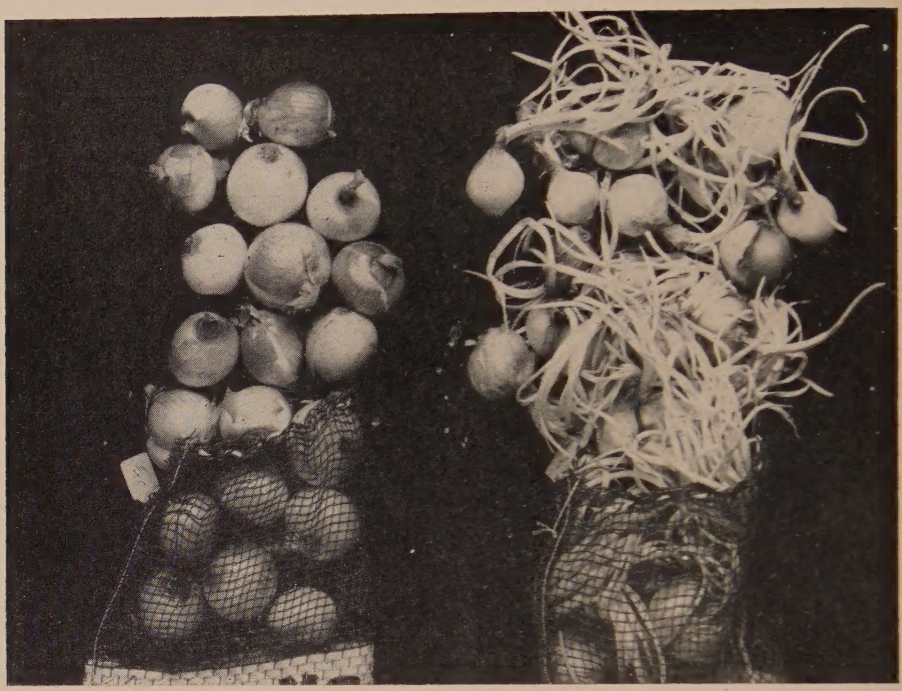

Fig. 1. Comparative sprouting of Brigham Yellow Globe onions harvested September 8, 1950, from plants sprayed with 2500 p. p. m. maleic hydrazide (left), non-treated controls (right). Photograph taken May 10, 1951.

the development of longer keeping types with better storage quality. Most of the highest yielding hybrid onion have poor keeping qualities. A preharvest foliage spray of maleic hydrazide has prolonged by several months the storage life of many of these hybrids. The complete inhibition of sprouting and reduction in storage breakdown may transform the poor keeping quality of many otherwise desirable hybrids into onions which may keep equally as well as some of the better storage selections of Downing and Brigham Yellow Globes.

The time of applying maleic hydrazide to the growing onion crop for the inhibition of storage sprouting is very important. Effectiveness of the chemical is dependent upon its absorption by the leaves and translocation to the bulb. Accordingly, the leaves must be alive and green. However, if the treatment occurs too early in the season when the onions are still growing rapidly, hollow or puffy bulbs result which keep very poorly in storage. Thus, with onions, maleic hydrazide should be applied when the bulbs have matured but while the tops are yet green. This is usually 1 to 2 weeks before harvest (Table 1).

TABLE 1—Summary of recommendations for the inhibition of sprouting and reduction of storage losses with preharvest foliage sprays of maleic hydrazide

Crop	Time of application	Spray concentrations of maleic hydrazide	Results
Onion	1 to 2 weeks before harvest. Bulbs should be mature; tops beginning to fall but still showing green.	2500 p.p.m. (0.25%) for complete inhibition of sprouting. 500 to 1000 p.p.m. (0.05 to 0.1%) will delay and reduce sprouting.	Storage sprouting completely eliminated regardless of temperature. Losses from breakdown reduced
Potato	2 to 6 weeks before harvest. Most effective if chemical is applied to the foliage when the tubers are only partially grown.	2500 p.p.m. for complete inhibition of sprouting. 500 to 1000 p.p.m. gives almost complete sprout inhibition if applied 4 to 6 weeks before harvest.	Sprouting and shriveling delayed or completely eliminated. Less sugar accumulates at low storage temperatures.
Sugar Beet	2 to 6 weeks before harvesting is anticipated.	2500 p.p.m.	Inhibits sprout and root growth in storage. Temperatures in storage piles are lower. Sugar losses during storage reduced.
Vegetable root crops (carrot, beet, parsnip, turnip, rutabagas)	1 to 3 weeks before harvesting is anticipated.	2500 p.p.m.	Inhibits sprout and root growth. Storage quality greatly improved and shelf life prolonged.

*Maleic hydrazide as MH-30 may be purchased from the United States Rubber Company, Naugatuck Chemical Division, Naugatuck, Connecticut. As of this writing, sales are yet limited by law to those who arrange for qualified technical personnel to supervise tests and report on results.

Three quarts of MH-30 per 100 gallons of water is approximately 2500 p. p. m. of maleic hydrazide.

One pint to one quart of wetting agent should always be added per 100 gallons of spray solution.

Approximately 150 gallons per acre of spray solution, sufficient to wet the foliage to run-off, is required per acre.

POTATOES

Single spray applications of 1000 to 2500 p. p. m. of maleic hydrazide applied 4 to 6 weeks before harvest to the vines of Irish Cobbler and Pontiac varieties have resulted in a complete inhibition of sprouting in storage. Tubers showed no sprout growth when held continuously for 7 months at 55° F. Because of excess sprouting and shriveling (dehydration), non-treated potatoes in the same storage were a total loss (Fig. 2).

If concentrations are adjusted, there is considerable latitude as to the time during the growing season that the chemical can be applied, with various degrees of effectiveness. Any desired degree of sprout inhibition or storage dormancy may be achieved. No sprouting results if sprays containing 2500 p. p. m. of maleic hydrazide are applied early while the tubers are still growing. Even 1000 p. p. m. may give almost complete control if applied when the tubers are immature and about one to two inches in diameter. Later treatments of 1000 to 2500 p. p. m. applied a few days or a week before harvest delay sprouting

Fig. 2. Comparative sprouting of Pontiac potatoes harvested September 4, 1950, from plants sprayed with 2500 p. p. m. maleic hydrazide approximately 6 weeks before harvest, (left), non-treated controls (right). Photograph taken April 1, 1951.

but the inhibition is not complete. Yield data suggest that high concentrations of the chemical may be applied early in the growing season to insure a complete control of sprouting with no effects on vine growth, yield of U. S. No. 1 tubers, or impairment of quality.

The dormancy induced in potatoes by spraying the vines with maleic hydrazide is so complete that tubers are useless for seed purposes. The treatment is recommended exclusively for table stock and for potatoes which are to be processed. No means are yet known whereby this dormancy may be broken. It seems that the ability of the tuber to produce sprouts is completely destroyed.

In addition to providing a means of completely controlling sprouting at high storage temperatures (above 45° F.), preharvest foliage sprays of maleic hydrazide may improve the quality of potatoes held at low temperatures (below 45° F.). Treated tubers accumulate less sugar. When processed, they produce lighter colored chips. Apparently, at low storage temperatures conducive to sugar accumulation in potatoes, maleic hydrazide has the very desirable characteristic of partially blocking the enzymatic conversion of starch to sugar.

SUGAR BEETS

In the storage of sugar beets at processing plants, losses in sugar may exceed one pound per ton each day. In large storage piles mild fall temperatures frequently induce considerable sprouting, heating and storage breakdown. Preliminary experiments with maleic hydrazide indicated that foliar applications of 2500 p.p.m. applied 2 to 6 weeks before harvest result in a complete inhibition of sprout and root growth. Consecutive thermocouple readings within storage piles revealed that temperatures were several degrees cooler. Beyond the advantage of sprout inhibition, this is of practical significance in sugar beet storage since maleic hydrazide reduces respiratory losses and slows down all metabolic processes resulting in the destruction of sugar. In one comparative experiment covering a 35-day storage test of similar lots, total sugar losses were reduced to less than 1 percent of the original in beets harvested from a one-half acre plot which had received a 75-gallon spray application of 2500 p. p. m. of maleic hydrazide 3 weeks before harvest. Non-treated controls lost over 12 percent of their original sugar during the same 35 days of storage.

Spray concentrations of 500 to 5000 p. p. m. of maleic hydrazide have been applied to sugar beets at intervals between 6 weeks and 48 hours of harvest without noticeable effects on the growing plants. Furthermore, the chemical, irrespective of dosage or time of application, did not influence yield, beet size or the percentage of sugar in the beets at harvest time. The growth-inhibiting effects of the treatment are apparently confined to the storage period.

VEGETABLE ROOT CROPS

Tests conducted during the 1950 season suggest that storage sprouting can be delayed in carrots, beets, parsnips, rutabagas and turnips by preharvest foliar treatments of maleic hydrazide. Effective control of sprout growth was obtained at high storage temperatures (55° F.) when a spray concentration of 2500 p. p. m. was applied 1 to 3 weeks before harvest. No effect on yield or general appearance of the crops before harvest was noticeable. The storage dormancy induced in vegetable root crops was similar to that in onions, potatoes, and sugar beets. Generally, roots harvested from treated plants and stored over winter at 45° F. failed to grow even when planted the following spring.

GENERAL CONSIDERATIONS

A wetting agent (soap or detergent) should always be added to the spray formulations of maleic hydrazide. The sticking properties are improved and a uniform coverage results. With the proper wetting agent, such as Triton B-1956 for onions, very rapid leaf absorption occurs and effective inhibition of sprouting has resulted, even though heavy rains have occurred within a few hours after treatment.

Applications of sprout inhibitors to growing crops offer an advantage in that spray equipment is generally available. Also, the effectiveness of maleic hydrazide has been shown to be much greater when applied to the leaves of growing crops than to relatively dormant bulbs, tubers, or roots after harvest.

Preharvest foliar treatments also have the added advantage that the food product is treated only indirectly. Accurate analytical assays[2] of onions, potatoes, and sugar beets show that after 7 months of storage, maleic hydrazide is present at concentrations ranging from 5 to 25 p. p. m. Detailed studies with animals, currently being conducted, suggest that maleic hydrazide as an agricultural chemical is relatively harmless. The extremely low concentrations occurring in produce treated for sprout inhibition are apparently of little consequence. Toxic accumulations in the soil of treated areas have also been considered. There is no evidence of any harmful effect carried over in the soil. Maleic hydrazide in the presence of soil is broken down very rapidly and persists for only a short time.

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[2]Details available from the Development Department, Naugatuck Chemical, Naugatuck, Connecticut.

CONTRIBUTION OF NATURAL INCREASE AND OF MIGRATION TO MICHIGAN'S POPULATION CHANGES

By JOHN F. THADEN
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MUCH INTEREST is commonly manifested in the periodic censuses of people by the United States Bureau of the Census. Extensive population increases are commonly accepted with acclaim and population decreases with forebodings. Within counties and communities noteworthy population increases have implications in connection with the extension of public utilities, demand for additional services and businesses, enlargement of school plants, streamlining of school districts, representation on county boards of supervisors, and many others.

With the publication on April 2, 1951, of the final population figures from the 1950 Census of Population for Counties in Michigan, the extent of the increase (or decrease) in the population of counties between 1940 and 1950 can be determined. Then, by integrating vital statistics from the State Department of Health with that of population change of a county, one has an objective measure of population mobility and of the sources of population change.

POPULATION GROWTH IN MICHIGAN, 1940-49

The growth of population in Michigan from 5,256,106 in 1940 to 6,371,766 in 1950—an increase of 1,115,660, or 21.2 percent—was due more to an excess of births over deaths than to in-migration. The addition of the 1.1 million persons was brought about by births exceeding deaths by a total of 742,129; in-migration from other states totaled 373,531.

Michigan's increase of 1.1 million during the decade was exceeded only by California, New York and Texas. Michigan's increase in population of 21.2 percent was exceeded only by Virginia, Utah, New Mexico, Maryland, Washington, Oregon, Nevada, Florida, Arizona,

TABLE 1—Extent and source of population change, by counties, in Michigan; 1940-49

(Minus (—) denotes decrease)

County	Population* 1950	Population change, 1940-49		Natural increase,† 1940-49	Migration 1940-49	Percent that migration was of estimated 1945 population
		Number	Percent			
Alcona	5,856	393	7.2	571	— 178	— 3.1
Alger	10,007	— 160	— 1.6	1,377	— 1,537	—15.2
Allegan	47,493	5,654	13.5	4,256	1,398	3.1
Alpena	22,189	1,423	6.9	2,980	— 1,557	— 7.3
Antrim	10,721	— 243	— 2.2	879	— 1,122	—10.4
Arenac	9,644	411	4.5	823	— 412	— 4.4
Baraga	8,037	— 1,319	—16.4	726	— 2,045	—30.5
Barry	26,183	3,570	15.8	1,837	1,733	7.1
Bay	88,461	13,480	18.0	11,777	1,703	2.1
Benzie	8,306	506	6.5	669	— 163	— 2.0
Berrien	115,702	26,585	29.8	11,564	15,021	14.7
Branch	30,202	4,357	16.9	1,912	2,445	8.7
Calhoun	120,813	26,607	28.2	12,460	14,147	13.2
Cass	28,185	6,275	28.6	1,070	5,205	20.8
Charlevoix	13,475	444	3.4	1,279	— 835	— 6.3
Cheboygan	13,731	87	0.6	1,490	— 1,403	—10.3
Chippewa	29,206	1,399	5.0	4,351	— 2,952	— 9.3
Clare	10,253	1,090	11.9	1,068	22	0.2
Clinton	31,195	4,524	16.9	3,378	1,146	4.0
Crawford	4,151	386	10.3	205	181	4.6
Delta	32,913	— 1,124	— 3.4	3,537	— 4,661	—13.9
Dickinson	24,844	— 3,887	—15.6	2,908	— 6,795	—25.4
Eaton	40,023	5,899	17.2	3,645	2,254	6.1
Emmet	16,534	743	4.7	1,816	— 1,073	— 6.6
Genesee	270,963	43,019	18.9	38,352	4,667	1.9
Gladwin	9,451	66	0.7	1,313	— 1,247	—13.2
Gogebic	27,053	— 4,744	—17.5	2,794	— 7,538	—25.6
Grand Traverse	28,598	5,208	22.2	2,898	2,310	8.9
Gratiot	33,429	1,224	3.8	4,163	— 2,939	— 9.0
Hillsdale	31,916	2,824	9.7	2,424	400	1.3
Houghton	39,771	— 7,860	—19.8	2,093	— 9,953	—22.8
Huron	33,149	565	1.7	4,098	— 3,533	—10.7
Ingham	172,941	42,325	32.4	22,845	19,480	12.8
Ionia	38,158	2,448	6.8	3,565	— 1,117	— 3.0
Iosco	10,906	2,346	12.7	996	1,350	13.9
Iron	17,692	— 2,551	—14.4	1,746	— 4,297	—14.8
Isabella	28,964	2,982	11.5	3,701	— 719	— 2.6
Jackson	107,925	14,817	15.9	10,624	4,193	4.1
Kalamazoo	126,707	26,622	26.6	14,259	12,363	11.0
Kalkaska	4,597	— 562	—12.2	469	— 1,031	—21.1
Kent	288,292	41,954	17.0	31,636	10,318	3.9
Keweenaw	2,918	— 1,086	—27.1	69	— 1,155	—33.4
Lake	5,257	459	9.6	205	254	5.1
Lapeer	35,794	3,678	11.4	2,914	764	2.3
Leelanau	8,647	211	2.5	771	— 560	— 6.6
Lenawee	64,629	11,519	21.7	6,687	4,832	8.2
Livingston	26,725	5,862	28.1	1,960	3,902	16.4
Luce	8,147	724	9.8	786	— 62	— 0.8
Mackinac	9,287	— 151	— 1.6	1,082	— 1,233	—13.1
Macomb	184,961	77,323	71.8	25,302	52,021	35.6

County	Population* 1950	Population change, 1940-49		Natural increase,† 1940-49	Migration 1940-49	Percent that migration was of estimated 1945 population
		Number	Percent			
Manistee	18,524	74	0.4	1,387	— 1,313	— 7.1
Marquette	47,654	510	1.1	4,726	— 4,216	— 8.9
Mason	20,474	1,096	5.7	1,710	— 614	— 3.1
Mecosta	18,968	2,066	12.2	1,684	382	2.1
Menominee	25,299	416	1.7	3,047	— 2,631	—10.5
Midland	35,662	8,568	31.6	6,574	1,994	6.4
Missaukee	7,458	— 576	— 7.7	988	— 1,564	—20.2
Monroe	75,666	17,046	29.1	7,411	9,635	14.4
Montcalm	31,013	2,432	8.5	2,596	— 164	— 0.6
Montmorency	4,125	285	7.4	465	— 180	— 4.5
Muskegon	121,545	27,044	28.6	19,044	8,000	7.4
Newaygo	21,567	2,281	11.8	2,099	182	0.9
Oakland	396,001	141,933	55.8	54,044	87,889	27.0
Oceana	16,105	1,293	8.7	1,287	6	0.0
Ogemaw	9,345	625	7.2	953	— 328	— 3.6
Ontonagon	10,282	— 1,077	—10.5	726	— 1,803	—16.7
Osceola	13,797	488	3.7	1,458	— 970	— 7.2
Oscoda	3,134	591	12.3	310	281	9.9
Otsego	6,435	608	10.4	646	— 38	— 2.3
Ottawa	73,751	14,091	23.6	9,690	4,401	6.6
Presque Isle	11,996	— 254	— 2.1	1,815	— 2,069	—17.0
Roscommon	5,916	2,248	16.1	452	1,796	37.5
Saginaw	153,515	23,047	14.0	19,942	3,105	2.2
St. Clair	91,599	15,377	20.2	9,378	5,999	7.2
St. Joseph	35,071	3,322	10.5	3,302	20	0.1
Sanilac	30,837	723	2.4	2,781	— 2,058	— 6.8
Schoolcraft	9,148	— 376	— 4.1	1,195	— 1,571	—16.8
Shiawassee	45,967	4,760	11.6	5,011	— 251	— 0.6
Tuscola	38,258	2,564	7.1	3,735	— 1,171	— 3.2
Van Buren	39,184	4,073	11.6	2,096	1,977	5.3
Washtenaw	134,606	53,796	66.5	15,834	37,962	35.3
Wayne	2,435,235	419,612	20.8	289,478	130,134	5.9
Wexford	18,628	652	3.6	1,935	— 1,283	— 7.0
Michigan	6,371,766	1,115,660	21.2	742,129	373,531	

*U. S. Bureau of the Census, "Population Of Michigan, By Counties, April 1, 1950", 1950 Census of Population-Advance Reports, Series PC-8, No. 21A (April 1, 1951).
†Computed from data pertaining to births and deaths in the Annual Reports of the Commissioner of the Michigan Department of Health.

and California, which had increases from about 24 to 53 percent. Except for California, all are less populous than Michigan.

The increase in population in Michigan during the 'thirties was somewhat above the national average; during the 'forties it was considerably higher than that of the country as a whole—21.2 percent, as compared with 14.5 percent.

In general, a gradually increasing proportion of the nation's population has sought Michigan as a place to live and to make a living.

This percentage, which was 1.7 in 1850 had increased to 4.2 by 1950. Michigan with its diversified agriculture and manufacturing activities, in conjunction with its strategic ecological location, between the East and the Mid-West, can be expected to maintain, or even to advance this percentage of the nation's population.

Despite a very substantial growth in population in the state during the past decade, 15 counties experienced a loss; 11 of them are in the upper peninsula and four are in lower Michigan (Table 1). The losses ranged from 1.6 percent in both Alger and Mackinac Counties to 27.1 percent in Keweenaw County. Houghton, was next to Keweenaw County with a population decrease of 19.8 percent. The losses in these two counties were probably associated considerably with the diminishing copper mining activities. Changes in the operation of the Ford plants in Baraga and Dickinson Counties have influenced the movement of population in these counties.

The absolute losses in population ranged from 151 in Mackinac County to 7,860 in Houghton County, both in the upper peninsula. During the decade of the 'forties, the population of the upper peninsula decreased 21,286 despite a natural increase of 31,163. This loss was the result of migration—52,449 more persons migrated from these counties than to them. Migration tends to reflect, in part, differences in economic opportunities.

A total of 68 counties gained in population during the decade 1940-49. Increase in population varied from 0.4 percent in Manistee County to 71.8 percent in Macomb County. Besides Macomb, several other counties also experienced more than a 50-percent increase in population—namely, Washtenaw, 66.5 percent, and Oakland, 55.8 percent. Increases in population are frequently most pronounced in small areas of counties; they were closely associated with defense manufacturing activities during World War II and with various kinds of manufacturing activities since then. All social institutions are affected by such great population changes. For example, in one school district in Washtenaw County (Willow Run) the school census skyrocketed steadily from 136 in 1936 to 2,767 in 1950—a one-room-one-teacher school of the early 'thirties became a 80-teacher school in the late 'forties.

The absolute gains in population ranged from 66 in Gladwin County to 419,612 in Wayne County. The bulk of this increase in Wayne County took place in Detroit since it comprises over three-fourths of the county's population. However, percentage-wide the population

of Detroit increased only about 13 percent, while the remainder of the county increased over 40 percent.

The population increase amounted to 25,000 or more in the counties of Berrien, Calhoun, Genesee, Ingham, Kalamazoo, Kent, Macomb, Muskegon, Oakland, Washtenaw and Wayne. In these 11 counties are located 37 of the 54 cities of 10,000 or more population. Despite appreciable proportions of good agricultural land in these counties, these population increases tend to reflect favorable economic opportunities in industrial occupations.

NATURAL INCREASE

During the decade 1940-49 births totaled 1,286,445 and deaths totaled 544,316, a ratio of better than two to one. The difference between births and deaths resulted in a natural increase of nearly three-fourths of a million (742,129). Births exceeded deaths by 69 in Keweenaw County, the smallest natural increase in any county, to as much as 289,478 in Wayne County. Births also exceeded deaths by 20,000 or more in the counties of Genesee, Ingham, Kent, Macomb and Oakland.

In proportion to the estimated population in 1945—mid-point between the populations of the 1940 and 1950 censuses—the largest natural increase took place in the counties of Otsego, Midland, Muskegon, Macomb, Oakland, Genesee, Chippewa and Ingham. Most of these counties were meccas for many young migrants during the decade —mostly factory workers, among whom the birth rate was relatively high and the death rate relatively low.

It is quite likely that the total natural increase in population in Michigan during the decade 1940-49 was somewhat larger than 742,129, because of a larger percentage of births than of deaths being non-registered. There are no figures on the completeness of death registration in Michigan. Probably the underenumeration of deaths is less than one-half of 1 percent. If one assumes that the death registration was 99.5 percent complete during the past decade, then the estimated total number was approximately 547,050.

Birth registration was probably about 98.4 percent complete in Michigan during the decade.[1] On the basis of this assumption, the estimated total number of births was approximately 1,307,360. The difference between the total number of births and of deaths, when

[1]United States Public Health Service, National Office of Vital Statistics, Washington, D. C., "Estimated Completeness of Birth Registration, United States, 1935 to 1944", Vital Statistics-Special Reports, Vol. 23, No. 10, Sept. 30, 1946, p. 228.

allowances are made for underregistration, as here indicated, results in a natural increase of 760,310. Therefore, the natural increase in Michigan may have been larger by about 18,000 than that indicated in Table 1, and the net migration to the state may have been less by the same amount. However, the figures in the table are based on *registered* births and *registered* deaths. Completeness of registration, especially of births, probably varied considerably among the various counties. A birth registration test by the United States Bureau of the Census indicates that completeness of birth registration varied from as low as 78.3 in Alger County to 100 percent in 15 counties, from December 1, 1939 to March 31, 1940.[2]

MIGRATION

No doubt every county had some people migrate to it as more or less permanent residents during the decade. Nevertheless, in more than one-half (43) of the 83 counties, migration from the county (or out-migration) was in excess of in-migration (Table 1). The out-migration from these 43 counties totaled 82,341. Their destination is not known, although probably the great majority migrated to the various industrial centers of Michigan. Of the 22 counties with no urban centers (that is counties with no incorporated places with 2,500 or more inhabitants), 15 experienced a greater out-migration than in-migration.

Despite the fact that Michigan's growth in population during the past decade must be attributed largely to internal growth through the excess of births over deaths, there are 12 counties whose growth was due more to in-migration than to natural increase. Increase in population in the following counties was due mainly to in-migration, as follows: Cass County, 83 percent; Roscommon County, 80 percent; Washtenaw County, 71 percent; Macomb County, 67 percent; Livingston County, 67 percent; and Oakland County, 62 percent.

Growth in population in 28 counties was due more to natural increase than to migration. Twenty of them are *south* of a line drawn from Bay City to Muskegon.

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[2]Bureau of the Census, Vital Statistics, Special Reports, Vol. 17, No. 18, "Studies in Completeness of Birth Registration", April 20, 1943, pp. 257-9. The 1950 Birth Registration Test, by the National Office of Vital Statistics, of the U. S. Public Health Service, will be finished some time in the fall of 1951.

In 28 other counties, the growth in population was due to natural increase. Twenty-one of them are *north* of a line drawn from Bay City to Muskegon.

On the basis of the source or principal source of population growth from 1940 to 1950, the 68 counties may be placed in the following three categories:

Population increase due more to in-migration than to natural increase	*Population increase due more to natural increase than to in-migration*		*Population increase due to natural increase*	
Berrien	Allegan	Lapeer	Alcona	Luce
Branch	Barry	Lenawee	Alpena	Manistee
Calhoun	Bay	Mecosta	Arenac	Marquette
Cass	Clare	Midland	Benzie	Mason
Iosco	Clinton	Muskegon	Charlevoix	Menominee
Lake	Crawford	Newaygo	Cheboygan	Montcalm
Livingston	Eaton	Oceana	Chippewa	Montmorency
Macomb	Genesee	Oscoda	Emmet	Ogemaw
Monroe	Grand Traverse	Ottawa	Gladwin	Osceola
Oakland	Hillsdale	Saginaw	Gratiot	Otsego
Roscommon	Ingham	St. Clair	Huron	Sanilac
Washtenaw	Jackson	St. Joseph	Ionia	Shiawassee
	Kalamazoo	Van Buren	Isabella	Tuscola
	Kent	Wayne	Leelanau	Wexford

One should relate out-migration to total population in order to get a perspective of relative migration between counties. For example, the out-migration of 1,564 from Missaukee County does not seem large in comparison with the out-migration of 2,045 from Baraga County. Nevertheless, in proportion to the estimated 1945 population—mid-point between decennial censuses—out-migration from Baraga County was larger (30.5 percent) than that from Missaukee County (20.2 percent). Out-migration was relatively large (16 to 33 percent of estimated 1945 population) from eight counties besides Baraga and Missaukee: Keweenaw, Gogebic, Dickinson, Houghton, Schoolcraft, Ontonagon, Kalkaska, and Presque Isle.

The county with the largest in-migration in proportion to population was Roscommon. This was followed by Macomb, Washtenaw,

Oakland, and Cass. In these cases the percentage that migration was of the estimated 1945 population ranged from 20 to 37.

It will be worth while to make analyses of urban, rural-farm, and of rural-nonfarm populations, by counties, as is done in this article for the total population. This will be possible to a considerable extent when the final population figures from the 1950 census pertaining to the urban and rural peoples become available within the next 18 months.

USE OF PLASTICS IN PRESERVING SPECIMENS OF PLANT TISSUE SHOWING NUTRITIONAL DEFICIENCY SYMPTOMS

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PLANT MATERIALS showing nutritional deficiency symptoms can be easily and inexpensively preserved in plastic mountings. When carefully made, such mountings are durable and afford a convenient and effective means of demonstrating nutritional deficiency symptoms of plants, especially to small groups of people when colored photographic slides are unavailable or inappropriate for the occasion (Fig. 1).

Detailed directions, with rather complete bibliographies, on the subject of preserving and mounting biological specimens in plastics are presented by Fessenden (2) and the Castolite Company (1). The purpose of this paper is to describe, particularly for the benefit of agricultural workers who are limited in time and equipment, a simplified procedure for embedding specimens of plant tissue in plastic materials.

SPECIMEN COLLECTION AND PRESERVATION

Obtaining representative specimens illustrating typical deficiency symptoms is perhaps the most important part of the procedure. Normal leaves should also be secured and mounted with the deficient specimens for comparative purposes. Care must be taken that the fresh, green plant materials are not injured or even slightly bruised in collecting, drying, and handling. If the delicate outer membrane is punctured or weakened, the liquid plastic will enter and differentially impregnate portions of the dried tissue, giving an undesirable appearance which will affect considerably the value of the finished piece.

The fresh specimens should be dried as quickly as possible after removal from the plant. This can be accomplished by placing the

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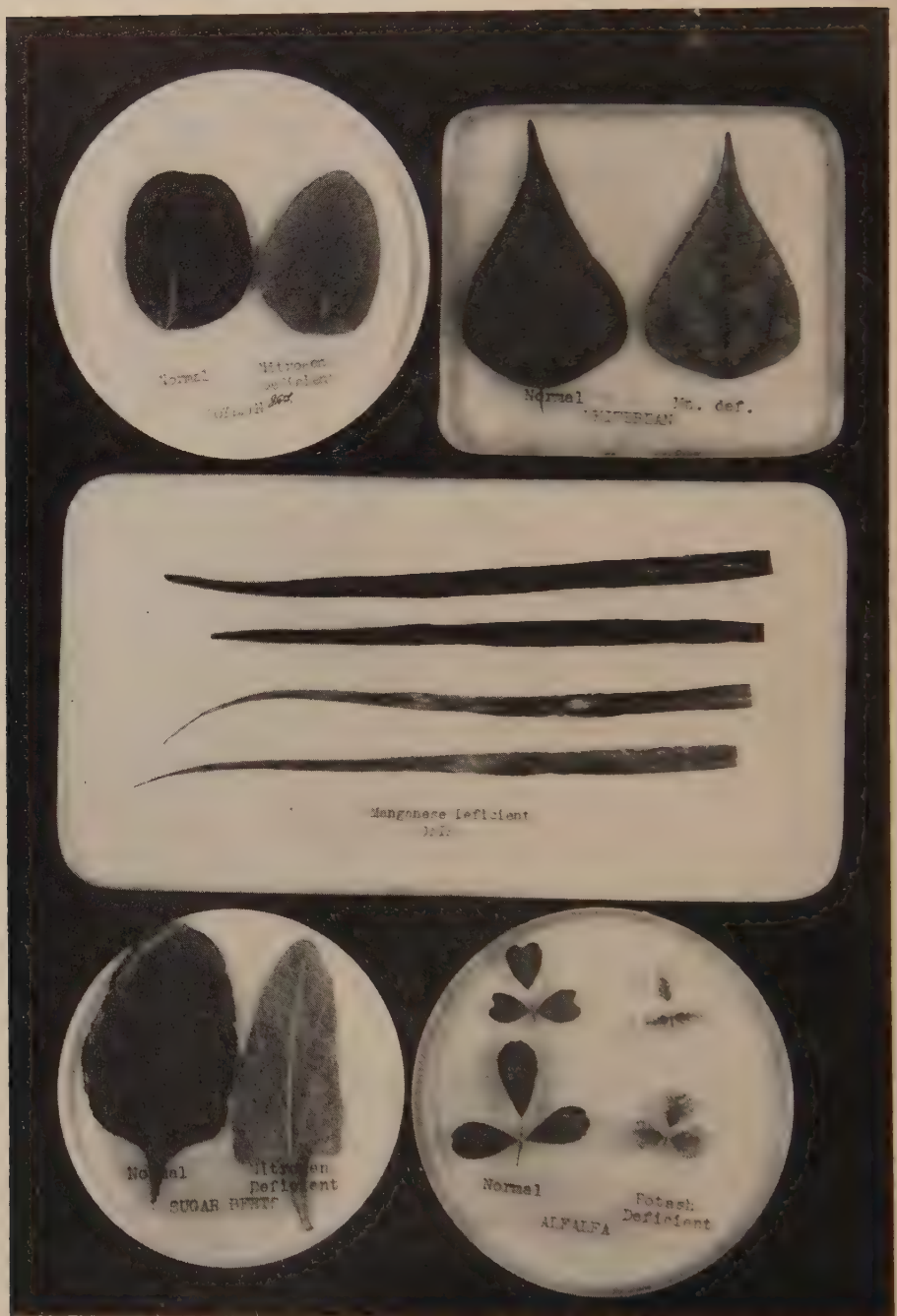

Fig. 1. Examples of plant specimens showing deficiency symptoms, embedded and preserved in plastic. White finely powdered material, such as calcium carbonate, may be mixed into the transparent plastic to form the white background. The labels are typed on thin onionskin paper and embedded with the specimens.

fresh leaves in a layer of clean quartz sand in a porous cardboard container. More sand is then gently poured over the specimens to hold them flat as they dry. Drying is best accomplished by heating the sand-covered specimens for 24 hours in an oven with a temperature of 70° to 75° C. After dehydration of the tissues the sand particles should be carefully removed with gentle suction. This can be accomplished best with a soft rubber tube attached to an aspirator through a trap bottle to catch the sand grains. The dry leaves are very fragile and easily bruised.

The drying procedure, as outlined above, is suitable for preserving the various shades of chlorophyll and chlorotic patterns typical of most of the common nutrient deficiencies. Special attention must be given to symptoms involving accumulations of anthocyanins or leaves having high contents of complex sugars. Fessenden (2) presents detailed directions for the preparation and use of preserving fluids for such special cases. Treatment with these preserving fluids ordinarily should follow the drying process. The dry specimens may be kept for a long period of time if stored in a dry, dark atmosphere before mounting in plastic. The mounted specimens should likewise be stored in the dark since none of the treatments will completely prevent fading if the specimens are subjected to intense sunlight for long periods of time.

EMBEDDING THE SPECIMEN

Molds for casting the plastic should be of a size to accommodate the specimen without crowding. Glass containers such as petri dishes or square icebox storage jars are suitable for most materials.

The plastic material referred to here is a commercial liquid casting material known as "Castolite". A small amount of oxidizing catalyst added to the liquid material causes the plastic to polymerize and harden. A layer of the liquid material into which this catalyst has been stirred is poured into a suitable mold and allowed to gel or partially harden. The stem of the dried leaf specimen is grasped with tweezers and the leaf is carefully immersed in the liquid plastic. Additional plastic, to which the catalyst has been added, is poured over the gelled material in the mold to form a thin liquid layer. The plastic-coated leaf is then gently eased onto this liquid layer, carefully forcing out air bubbles that would otherwise be entrapped under the leaf. Best results will be obtained if *the leaf is placed upside down in the mold*, that is, with the surface that is desired to be exhibited facing the bottom of the mold.

Suitable labels for embedding with the specimens may be fashioned by lettering with India ink on thin Vinylite plastic strips or by typing on very thin onionskin copy paper. The paper becomes almost transparent when saturated with the liquid plastic.

After the plastic has gelled sufficiently to hold the specimens in place, additional catalyzed plastic is poured over them until they are completely covered. This layer should also be allowed to gel.

The background layer of plastic should then be poured over the embedded specimens. White backgrounds seem to be the most desirable to show up chlorotic patterns in green leaves. This white plastic may be obtained by mixing into the liquid plastic a white opaque dye or some insoluble white material such as powdered calcium carbonate or barium sulfate. When this layer gels slightly it may be covered with cellophane or wax paper. This will give a final hard surface on the exposed side of the mounting, otherwise it remains sticky for a long period of time.

As the plastic polymerizes and hardens it shrinks slightly, allowing easy removal from the mold after it has completely cured. When the

Fig. 2. Specimens are embedded face downward. As the plastic hardens it shrinks slightly, allowing easy removal from the mold (left). The bottom of the piece then becomes the top and gives a clear, hard surface that requires no sanding or polishing (right).

finished piece is removed from the mold the bottom surface, now glassy, hard and smooth, is actually the top or exposed surface of the mounting (Fig. 2).

Heating the plastic material increases its rate of hardening. The amount of catalyst added per volume of plastic has much to do with the rate of polymerization and the appearance of flaws in the finished piece. These two factors vary with the type of liquid casting material and specific directions for the type used should be consulted before attempting the procedure. The method outlined above requires about 15 to 20 minutes for the actual mounting. The cost of materials ranges from 30 cents to one dollar depending on the size of the casting. No sanding or polishing is required with this method.

Finished mountings of plant materials embedded in plastics offer an attractive means of demonstrating foliage symptoms of plant nutrient deficiencies. They are effective and durable aids for teaching, are convenient to use, and are neither expensive nor time-consuming to make.

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STUDIES ON THE CLEANING AND SANITIZING VALUE OF HIGH PRESSURE STEAM FOR EXPOSED SURFACES

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The use of steam as a cleaning and sanitizing agent in dairy and food plants has been accepted for many years. With the development of portable steam generators, the advantages of steam cleaning have been made available where a large generator was not practical. In addition, portable steam generators have the advantage of furnishing a high-jet velocity line pressure. They have opened new fields for steam cleaning in addition to sanitizing of the utensils, containers, etc., of the dairy or food plant. Many of these portable steam cleaners have been used for the surface type of cleaning such as barn floors, stables and hog pens. Although studies have been made of the effects of "trapped" steam (e.g., inside a milk can) there is little information available as to the value of surface cleaning where sanitation is also of importance. It is obvious that the steam delivered under pressure is an excellent means of cleaning and the experience of some operators indicates that there is a lowered incidence of disease when steam cleaning is employed.

The purpose of these studies was to determine what effect the steam itself, when applied in this manner, will have on the bacteria present. A second portion of the work was to evaluate the effectiveness of the alkali solutions which are being added to the steam as a disinfectant and to investigate the possible effectiveness of other compounds which might be mixed with the steam for this purpose.

The general plan of the work was to utilize the technics employed by Mallmann *et al.* (1) for the study of dishwashing procedures. The test surfaces were covered with a soil containing the test organisms. The steam was then applied to these test areas, using a flat nozzle.

ARTICLE 34-4

By scraping the remaining soil from the surface after cleaning and making bacteriological examinations, the efficiency of the various operations was studied.

EXPERIMENTAL

Steam Supply—The source of steam for these studies was a mobile steam generator designed so that cleaning solutions or sanitizers could be metered at a constant rate into the water line as it entered the heating coil. The steam was delivered to the hose line at a pressure of 90 to 120 pounds per square inch. The materials were pumped through the machine at a total rate of 90 gallons per hour. When sanitizers and cleaning solutions were used, they contributed 2 to 4 gallons per hour of this total.

Test Surfaces—In order to obtain a uniform soil, the test surfaces were designed to utilize the apparatus of Mallmann *et al.* for soiling restaurant dishes. These test blocks consisted of 9-inch disks, about 2 inches thick, of various materials. Those which proved to be the most satisfactory were the unpainted wood and the sheet metal fastened to a wooden disk.

Soil—The first series of tests showed that the soil used for the dishwashing machine studies was too easily removed and any differentiation of various cleaning methods was not possible. Double spraying of the disks and baking at 171° C. for 18 hours were tried, but all methods of spray application resulted in a soil which was too easily removed. Thus, it was necessary to develop a more tenacious soil and to apply it by brushing. After several trials, the following soil was found to be satisfactory:

Wheat flour	120 grams
Dried egg yolk	120 grams
Wall paper paste (precooked)	52 grams
Evaporated milk	210 grams
Peanut butter	35 grams
India ink	7–10 ml.
Water	(approx.) 460 ml.

These materials, except the ink, were mixed thoroughly in a Waring blender with as little water as possible to effect a smooth preparation. The suspension of test organisms was added, followed by the India ink

which gave an indication of the complete dispersion of the test organisms throughout the soil.

The soil was applied with a two-inch brush in two to three successive layers, depending upon the thickness desired. The disks were dried at 37° C. overnight before use. To minimize the variations introduced by this technic, every disk was divided equally into a test area and an untreated control area and each was sampled.

Methods—The steam was applied to the "test half" of the disk by means of a nozzle on the steam hose which forced the steam out through a 2 x ⅛-inch slit which was directed toward the surface to be cleaned. The nozzle, held within a distance of one inch from the surface, was moved back and forth across the test area (32 square inches) manually for the particular time interval being used—usually 10 or 15 seconds. The uniformity of application could be readily judged by the operator according to the disappearance of the India ink from the test surface. An interval of 10 seconds was just sufficient to accomplish this process with the soil employed. Several attempts were made to do this mechanically to obtain a more constant application of the steam; however, the advantage which might have been obtained did not seem to justify the type of apparatus that would have been required.

After the surfaces had been steamed, the organisms remaining were enumerated as follows: on each disk the remaining soil was removed by means of a scraper or scalpel from a measured, representative area of the control portion and a similar area of the steamed portion of the disk. These scrapings were collected and placed in a dilution bottle containing 99 ml. of sterile distilled water. Suitable dilutions were plated, using tryptone-glucose extract agar (Difco).

Test Organisms—For most of the tests, spores of *Bacillus subtilis* were used. The spore suspensions were prepared by growing *B. subtilis* in sterile 32-ounce medicine bottles with a layer of tryptone-glucose extract agar covering the flat side. After 8 days' incubation at room temperature, the organisms were washed off the agar surfaces with sterile, distilled water. This suspension was heated in a sterile test tube to 50-60° C. for 30 minutes to destroy the vegetative cells and heat-labile spores. The material was centrifuged and washed several times, then refrigerated immediately. The suspensions were titrated prior to use and adjusted to give approximately one million cells per square inch of treated surface.

In the tests in which it was desired to have a test organism of lowered heat resistance, *Micrococcus caseolyticus* was employed. This organism was found by Mallmann and co-workers (1) to have a thermal death point of 158° F. for 15 seconds and also to be sufficiently resistant to desiccation to withstand overnight drying in the soil. This organism was handled as any standard bacteriological culture.

DISCUSSION

In making an evaluation of this method of steam cleaning, it is necessary to consider two separate phases—mechanical removal of the microorganisms and lethal action of the heat or chemical agent. Since the temperatures applied to the test surface could not be in excess of 100° C., spores of *B. subtilis* were selected as the test organism. These are capable of resisting this degree of heat and would be a good indicator of the mechanical removal taking place.

In the series of tests reported in Table 1, it can be seen that the removal of the test organism was usually better than 95 percent; in six of the trials it was better than 99 percent. One should remember that in the preliminary work, there was a 99.99 percent removal or better in almost every case. Only after the development of the very tenacious soil was it possible to retain this percentage of organisms on the test surface for 10 seconds. To demonstrate that these organisms were being removed mechanically and not being killed on the surface, the cleaning was done in a sterilized container which would collect the condensed steam and water which were washed off. An examination of the data in column four of Table 1 shows that the recoveries represented 50 percent or more of the organisms applied. In three cases the count of the collected water exceeded that of the original inoculum, owing perhaps to the dispersion of the clumps by the steam and inaccuracies inherent in the technic. This would indicate that the reduction of organisms on the surface was primarily due to the mechanical removal by the steam. It would also imply that where the loosened soil is not completely removed from a treated area, any heat-resistant organisms will remain on the surface.

Similar studies were conducted with an organism having a lower heat resistance. For this purpose *M. caseolyticus* was selected. This series is reported in Table 2. In most of these trials the percent removal was greater than 99 percent and recovery of organisms in the collected run-off was very low. Thus, it is shown that with this test

TABLE 1—The effectiveness of high-pressure steam in removing B. subtilis spores from a test surface and the demonstration that the spores were not killed as indicated by the number of viable cells in the run-off

Disk No.	Initial number of organisms*	Number of organisms surviving on the surface*	Percent reduction on the surface	Number of organisms recovered in the run-off*
1	672,000	1,720	99.74	336,000
2	232,500	6,250	95.31	700,000
3	352,000	3,250	99.08	289,000
4	330,000	41,350	87.50	254,000
5	1,165,500	2,560	99.78	.....
6	756,000	19,000	97.48	.....
7	425,000	11,560	97.28	262,000
8	514,000	3,450	99.31	312,000
9	65,000	4,000	93.75	428,000
10	475,000	14,000	96.97	490,000
11	708,800	3,750	99.47	345,000
12	790,000	2,600	99.67	332,000

*Expressed in organisms per square inch of test surface.

TABLE 2—The effectiveness of high-pressure steam in removing M. caseolyticus from a test surface and the demonstration of the lethal effect upon the bacteria removed as indicated by the viable cells in the run-off

Disk No.	Initial number of organisms*	Number of organisms surviving on the surface*	Percent reduction on the surface	Number of organisms recovered in the run-off*
1	1,669,000	9,063	99.46	3,100
2	3,575,300	7,090	99.80	1,000
3	5,197,500	50,625	99.03	0
4	866,300	1,504	99.83	1,870
5	59,850	2,313	96.14	0
6	1,050,000	5,188	99.51	0
7	6,142,500	40,625	99.34	0
8	1,375,000	25,940	98.11	0

*Expressed in organisms per square inch of test surface.

organism some of those cells which are mechanically removed from the soiled area by the steam are also destroyed due to the lethal action of the heat applied.

It was noticed that the steamed surfaces could usually be touched with the hand immediately after steaming. To determine, if possible,

the temperatures attained on the surface, a laboratory thermometer of the mercury-bulb type was fastened to a surface and readings were taken with the steam nozzle held at various distances. The following data were typical of several trials:

Nozzle distance	*Temperature*
½ inch	94° C.
1	80
1½	77
2	74
3	71

The highest temperature attained in any trial was 96° C. at one-half inch.

In an actual cleaning operation, the steam is applied to any one area for only a few seconds. Thus, it can be seen that the heat would be insufficient to kill resistant organisms on the surface. This was observed by Mallmann *et al.* (1) in studies on mechanical dishwashing.

The next phase of the studies was an evaluation of the killing effect of high pressure steam supplemented by alkali detergents recommended for use in the steam generator. There was no significant difference noted in the relative numbers of organisms remaining whether the cleaning was done with steam alone or steam plus an alkaline detergent. This was true of both test organisms. Some differences were noted in the numbers of organisms recovered in the run-off. The effect upon *B. subtilis* spores was not too great. When using *M. caseolyticus* the alkaline detergents were quite effective in killing the organisms removed. It was noted that the alkalinity of these solutions was greater than pH 11, which would account for this action.

Since these compounds were not effective in freeing the surface of organisms, a different type of sanitizer was indicated. A quaternary ammonium salt (alkyl dimethyl benzyl ammonium chloride) was selected because it would not be inactivated by the heat and would tend to have a residual effect on the surface treated. This material was tested against *M. caseolyticus,* and the data are presented in Table 3. When a 10-percent solution of the quaternary ammonium compound was added to the solution tank, no viable organisms could be recovered from the test surface.

TABLE 3—Percentage reduction of M. caseolyticus on the test surface with and without the quaternary ammonium compound added to the steam

Disk No.	Initial number of organisms*	Number of organisms surviving on the surface*	Percent reduction on the surface
Using Steam Alone			
1	1,401,800	59,375	95.76
2	829,000	36,250	95.63
3	125,000	16,735	86.61
4	1,072,000	30,000	97.20
Using 10% Quaternary Ammonium Compound Added to the Steam†			
5	897,800	813	99.91
6	1,291,500	3	99.99
Using 10% Quaternary Ammonium Compound Added to the Steam†			
7	5,000	0	100.00
8	635,000	0	100.00
9	1,181,300	0	100.00
10	12,100	0	100.00

*Expressed in organisms per square inch of test surface.
†A 10% solution added to the steam resulted in a concentration of 1–500 being applied to the test surface. Disks 5 and 6 were tested while the concentration of quaternary ammonium compound was building up to, but had not reached, the 1–500 concentration.

For all the data thus far reported, the test surface has been metal. In order to get a comparison of the removal on different types of surfaces, several experiments were run, using both metal and wood surfaces. As would be expected, there was no appreciable difference in the removal from these surfaces. However, there was greater variation in the individual results when the rougher surfaces were tested. An attempt was made to use concrete disks, but it was so difficult to scrape off the residual soil after cleaning that no conclusive results could be obtained. Visual inspection showed that the cleaning effect was similar to that obtained with wood, but no bacteriological studies were made.

Since the use of a quaternary ammonium compound seemed to give the best results in the laboratory, limited field tests were carried out to determine how effective this might be done under practical con-

ditions. A poultry house was selected for these tests. Comparative counts before and after cleaning by the plant personnel were made by swabbing two adjacent areas of 4 square inches each. Table 4 shows that an effective reduction in bacterial population was evident after

TABLE 4—Bacterial reduction on various surfaces of a poultry house using 10% quaternary ammonium compound added to the steam

Type of surface	Initial number of organisms*	Number of organisms surviving on the surface*
Floor—smooth concrete	19,700	400
Wall—painted plaster	100	0
Dropping board—wood	57,500	700
Wire panel floor	22,500	600

*Expressed in organisms per 4 square inches, using a swab technic.

sanitizing in this manner. Later tests of a similar nature showed comparable results.

SUMMARY

A study of the cleaning and sanitizing value of high pressure steam for walls, floors and other surfaces was made.

Using *B. subtilis* and *M. caseolyticus*, the authors found that high-pressure steam removed most of the test organisms by mechanical action. A few viable bacteria were found on the surfaces after cleaning and many viable cells were found in the soil removed mechanically by the steam. These data show that the steam when applied for a short period is not necessarily lethal.

The addition of alkali compounds to the steam augmented lethal action on the bacteria removed mechanically by the steam but had little effect on the residual bacteria left on the surface after steaming.

When using a quaternary ammonium salt, no organisms could be found on the cleaned area.

Effective reductions in bacterial populations of surfaces were obtained in actual practice.

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GROWTH OF MIXED RED AND WHITE PINE PLANTATIONS IN THE UPPER PENINSULA

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In 1925 several three-acre mixed red pine *(Pinus resinosa)* and white pine *(Pinus strobus)* plantations were established for demonstrational purposes in the upper peninsula of Michigan. This was done cooperatively by members of the Extension Service, county authorities, and local groups interested in reforestation. These plantations were made to demonstrate that forest trees can be planted on many lands not particularly well suited for growing farm crops and that merchantable forest products can be grown on them in a relatively short time.

In the late summer and fall of 1950 measurements were made in five of the plantations, located in widely separated counties on different soils, to determine their growth and development. The location of the plantations, the soil types on which they grow, and detailed growth data on a per acre basis, are presented in Table 1.

Plantations 1, 2, 4 and 5 were established on abandoned farm land. Plantation 3 was planted on cut-over forest land that had been burned over by forest fire. Although the soils on which the five plantations grow possess sufficient fertility to produce from fair to poor yields of farm crops, they are often abandoned for farming purposes because of drainage, terrain, stoniness, or the difficulty of maintaining soil fertility (1) (2) (3).

No records were kept on spacing, mixture, size of planting stock, and ground cover at the time of planting. From inspection of the plantations, it appears that the original plantings were essentially mixtures of red and white pine alternately planted in rows, except for plantation 3 which shows no definite pattern of mixture. Distances between trees and rows vary some, but in general they are either 6 or 7 feet so as to achieve spacings shown in Table 1. Plantations 2 and 3 have some Jack pine (*Pinus banksiana*) planted with the red and white pine, but not in large enough number to change their com-

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TABLE 1– Growth and development of plantations at 25 years of age

Species	Original mixture and spacing in feet	Number of trees per acre	Number of merchantable trees per acre	Average DBH of all trees in inches	Average DBH of merchantable trees† in inches	Average total height of merchantable trees‡ in feet	Average merchantable height of trees in feet	Merchantable volume§ per acre	
								Standard cords unpeeled	Cubic feet
Plantation 1—Chippewa County. Soil, Bohemian very fine sandy loam									
Red pine	6 by 7, alternately red and white pine	485	455	7.3	7.3	36	16	22.2	1887
White pine		260	10	3.6	5.8	25	10	0.1	8
Total/Average		745	465	6.0	7.3	36	16	22.3	1895
Plantation 2—Gogebic County. Soil, Allouez loamy sand									
Red pine	6 by 7, alternately red and white pine mixed with a few Jack pine	210	200	8.2	8.4	32	18	14.2	1207
White pine		155	70	4.9	6.1	20	8	1.7	145
Jack pine		65	55	8.6	8.6	30	17	3.4	289
Total/Average		430	325	7.1	7.9	29	16	19.3	1641
Plantation 3—Ontonagon County. Soil, Ontonagon fine sandy loam									
Red pine	6 by 6, predominantly red and white pine, no uniform mixture	180	120	6.0	7.6	33	19	6.5	553
White pine		295	205	6.4	7.5	28	17	9.4	799
Jack pine		30	20	6.5	7.6	36	13	1.1	93
Aspen*	Natural reproduction	220	30	3.6	5.9	38	19	0.9	77
Total/Average		725	375	5.5	7.4	31	18	17.9	1522

TABLE 1—Continued

Species	Original mixture and spacing in feet	Number of trees per acre	Number of merchantable trees per acre	Average DBH of all trees in inches	Average DBH of merchantable trees† in inches	Average total height of merchantable trees‡ in feet	Average merchantable height of trees in feet	Merchantable volume§ per acre	
								Standard cords unpeeled	Cubic feet
Plantation 4—Menominee County. Soil, Onaway fine sandy loam									
Red pine	6 x 7, alternately red and white pine	390	240	5.6	6.7	31	16	9.2	782
White pine		325	190	5.1	6.1	25	9	4.5	382
Total/Average		715	430	5.4	6.4	28	13	13.7	1164
Plantation 5—Luce County. Soil, Kalkaska sandy loam									
Red pine	6 by 6, alternately red and white pine	325	290	6.0	6.2	26	12	7.0	595
White pine		340	80	4.0	5.5	25	8	1.3	111
Total/Average		665	370	5.0	6.0	26	11	8.3	706

*Aspen (*Populus tremuloides*) 1.0 inch in DBH and larger.
†Trees 5.0 inches in DBH yielding at least one 8-foot bolt to a usable top, or 4.0 inch top inside the bark are considered merchantable.
‡The average total height of all trees is 2 feet less than average total height of merchantable trees.
§Volume of the main stem above a 1-foot stump to a usable top, or 4.0 inch top inside the bark (see reference 5). Standard cords converted to cubic feet on the basis of 85 cubic feet per standard cord.

position materially. Planting stock is believed to have been two-year-old seedlings, which were planted in the bottom of plowed furrows. Only two of the plantations have had any kind of cultural care. Dead limbs in plantation 4 have been pruned to a height of 8 feet to reduce the fire hazard. When trees in plantation 1 were about 5 feet tall, leaders of white pine trees attacked by the white pine weevil (*Pissodes strobi*) were cut out in an effort to control damage from the insect.

The success of forest plantings depends chiefly upon survival and growth. To judge the success of pure pine plantations in the Lake States region, Paul O. Rudolf has developed stocking, diameter, and height curves, and success indices in terms of volume (4). These curves and indices are not strictly applicable to mixed stands, but those prepared for red pine seem to provide a fair basis for evaluating the plantations under discussion.

According to the above-mentioned curves and indices, the expected average development of a 25-year-old red pine plantation in this region is 24 to 27 feet in height, 3.2 to 3.9 inches in diameter at breast height, 370 cubic feet per acre in volume, and 540 trees per acre in stocking. Table 1 shows that in height, diameter, and volume all five of the plantations fall within, or are well above, those averages. In stocking, plantations 2 and 3 (if aspen is excluded) are below average, but plantations 1, 4 and 5 are well above average. This comparison indicates that the plantations as a whole, at least silviculturally, are a success.

By referring to the data in Table 1, it can be seen that red pine has done considerably better than white pine in height, diameter, volume and survival in plantations 1, 2, 4 and 5. Only in plantation 3 has white pine made better volume and diameter growth. Survival of red and white pine cannot be compared in plantation 3 as the original mixture is not known.

The white pine weevil has attacked all of the white pine trees at least once, and most of them repeatedly, year after year. It is estimated that as a result of weevil damage the merchantable height of white pine for pulpwood has been reduced an average of 6 feet. Red pine shows no signs of insect or disease attack and is straight and well formed.

Increment borings show that red pine is still making good diameter growth in all of the plantations. White pine, on the other hand, is becoming suppressed and slowing down markedly in diameter growth in all except plantation 3. Suppression of the white pine apparently is

serving the same purpose as thinning, and for this reason there is no need to thin the plantations at this time to maintain the good red pine growth rate.

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TRI-LEVEL HOUSE DESIGN FOR FARM HOMES[1]

By T. J. BREVIK
AGRICULTURAL ENGINEERING DEPARTMENT

WHEN COMPARED with other developments on the farm, the home is years behind in being convenient, comfortable, and practical. One of the reasons the house has been slow in being modernized is that home improvements must be paid for from farm profits. The success of a farm business is quite often reflected by a well-planned farm home, so today there is a growing interest in houses that fit farm life.

Since electricity is now generally available on the farm there is no reason why farm homes cannot have all the comforts and conveniences found in the city. Farmers need no longer be satisfied with just a conventional house—they can have a home that fits their needs and preferences; one that is convenient, comfortable and free of hazards. The tri-level house is a type that could fit very well into the business of farming and save many steps in the operation of the household (Fig. 1).

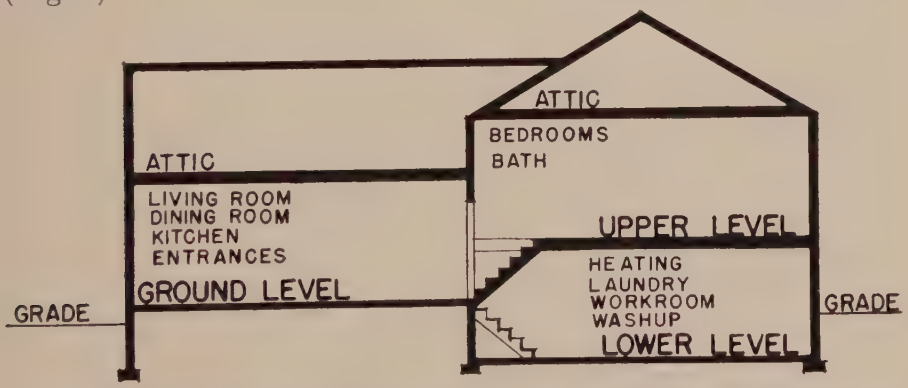

Fig. 1. Cross-sectional view showing tri-level arrangement and location of various rooms and areas.

In order to design better houses for the farm, there is a need for information on farm home life so that planners may prepare more

[1]A condensation of certain portions of a thesis presented by the author as partial fulfillment of the requirements for the degree of Master of Science, Michigan State College, 1950.

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adequate plans. A survey[2] recently completed in the North Central Region of the United States shows that the type of housing now in existence is entirely different from the type desired. This survey was a joint effort by the agricultural experiment stations of the 12 states in the North Central Region. The purpose was to gather information which would enable farm home planners to find out what kind of housing was wanted. Nearly 900 farms were randomly selected and the farm families interviewed. The survey was analyzed and among many findings were listed the following desired characteristics:

1. Sixty-five percent wanted the advantages of a one-story house, while only 25 percent had this type.

2. Seventy percent would like a home of five, six, or seven rooms, the preferences being divided as follows: a) 20 percent, five rooms; b) 30 percent, six rooms; and c) 20 percent, seven rooms.

3. Eighty-five percent regarded a basement as necessary.

4. Ninety percent would like: a) a sloping roof; b) a central heating plant; c) one or more porches; and d) a spare bedroom.

5. Seventy-five percent would: a) like a separate dining room, and b) plan to heat the whole house.

6. Sixty percent would: a) like a first-floor work room, and b) like to have the house and drive so planned that callers would come to the front door.

It was determined that the plan that would satisfy more people than any other single plan would be one with six rooms—kitchen, dining room, living room, three bedrooms, and bath. This would all be on one floor with a full basement. Few houses of this type now exist on Michigan farms.

A modern house designed with the above-mentioned specifications in mind would have a low appearance and a deep basement. Deep basements usually are dark, damp, difficult to ventilate, and inconvenient in access from the first floor and the outside. These conditions make the basement not too useful for many desired activities.

As a result of these problems, a somewhat unconventional design seemed worthy of investigation—the "tri-level house." A house of this design would have the following arrangement: On the lower level (basement area) would be located the heating plant, work room, storage, wash room, recreation room and wash-up area. One-half flight of stairs up (at ground level) would be the living room, dining room,

[2]Nickell, Paulena; Budolfson, Marie; Liston, Margaret; and Willis, Elizabeth. "Farm Family Housing Needs and Preferences in the North Central Region." Res. Bul. 378, Iowa Agr. Exp. Sta., Ames, Iowa. February 1951.

kitchen and entrances from the outside. One-half flight of stairs up from the ground level would be the upper level. On this level would be the bedrooms and bath. Figure 1 shows how this arrangement might be accomplished.

Fig. 2. Perspective view of tri-level farmhouse design.

In order to learn more about tri-level house design, houses of this type were visited in the Lansing-East Lansing area. The author is unaware of such houses on farms today. Few tri-level urban houses exist, but their popularity is growing. Tri-level owners are enthusiastic about the features of their homes.

From observation and interviews it would seem that a tri-level house offers the following advantages:

1. It places the busy part of the house (living room, dining room, and kitchen) near ground level and convenient to the outside.
2. It eliminates outside steps, thus reducing hazard and fatigue.
3. Because the lower level is not so deep in the ground as the conventional basement, the basement would be more convenient to the kitchen and the outside. Such a basement would also be easier for one to see out of, and would have better natural light and more adequate ventilation. The dampness problem would be decreased.
4. The sewage outlet can be below the basement floor, provided the area near the house slopes slightly. This would eliminate the need for a sump which may be required in a deeper basement.

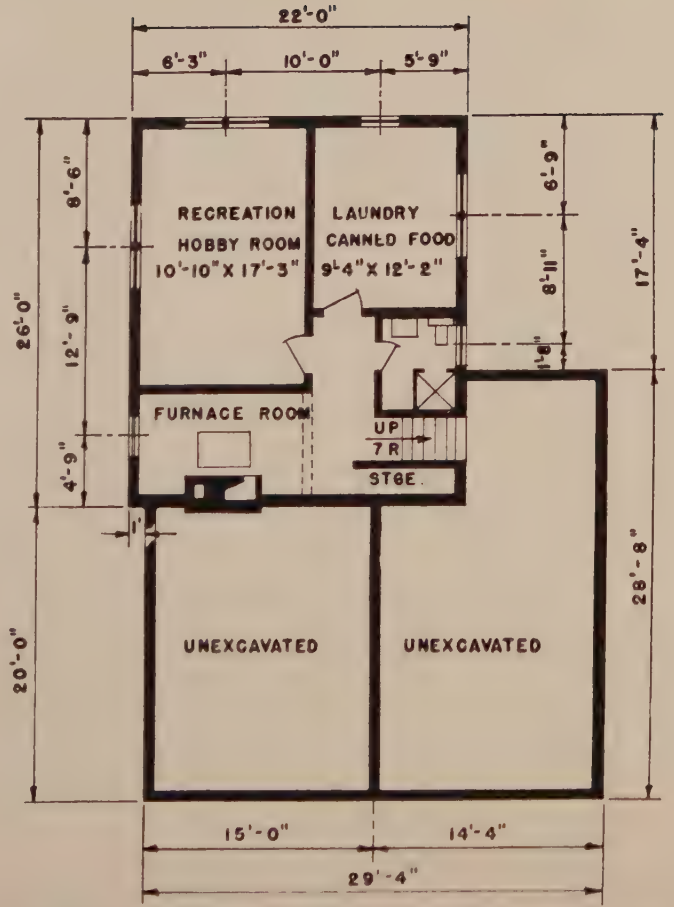

Fig. 3. Foundation and lower level plan for tri-level farmhouse.

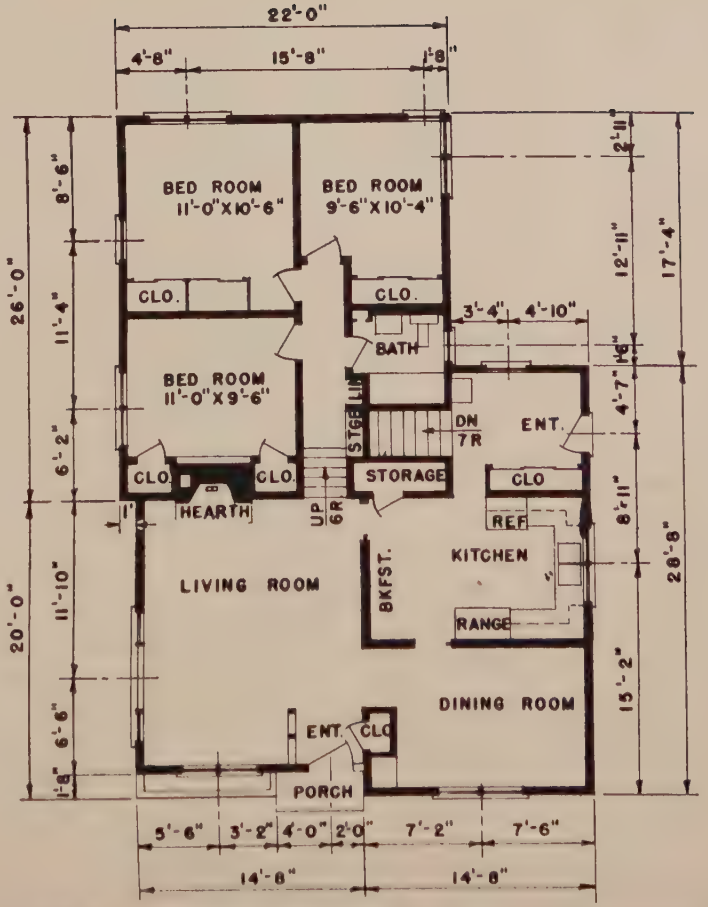

Fig. 4. Ground level and upper level plan for tri-level farmhouse.

5. More and better use can be made of the lower level.

6. An outside entrance to this lower level can easily be provided if desired, thus eliminating the need for going through a part of the house to get to the lower level.

7. The bedroom area is still convenient to the living area, but yet there is enough separation to insure privacy.

8. Cross-ventilation in the upper level is more easily obtained than is true in a one-story house.

9. Short flights of stairs reduce fatigue and hazard.

10. The three major areas are convenient and in close proximity to one another.

The farm house plan shown in Figs. 2, 3, and 4 was developed as a tri-level farm house. This is a six-room house having the following arrangement: The lower level contains the heating plant, wash room for the workers, laundry and canned food storage, and a large room which might be used for recreation, workshop or spare bedroom (Fig. 3). Up seven risers from the lower level is the ground level which has a living room, dining room, kitchen and outside entrances (Fig. 4). The service entrance faces toward the farm buildings, and the front entrance toward the drive. The service entrance in from the buildings contains storage for work clothes, deep freeze and wash up area for the workers. The bedroom level is up six risers from ground level and is over the lower level (Fig. 4).

There are about 1,200 square feet of floor space on the ground and upper levels, which would be comparable to a six-room house with all rooms on one floor. The lower level has 572 square feet of floor area which if planned properly would be ample for all activities on this level.

This plan contains most of the features desired in a farm home, such as:

1. Kitchen with a view of farm buildings.
2. Plenty of storage space throughout.
3. Basement or lower level convenient to both the kitchen and the out-of-doors.
4. Front door facing drive.
5. Good circulation throughout.
6. Eating space in kitchen.

This plan also has these features which may not be found in a one-story house with a full basement.

1. One outside step into the house.

2. Short flight of stairs to lower level.

3. A basement level which has adequate light, good ventilation, and is convenient and useful.

4. Bedroom level windows which are high enough to catch the summer breezes.

5. A separation of living and sleeping areas to insure privacy.

6. Possibility of sewage outlet below lower level.

A tri-level house would, if properly designed, fit the needs and preferences of farm life more adequately than many designs now in use.

OAK WILT IN MICHIGAN

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OAK WILT, the most destructive disease known to affect oak species, was found in Michigan for the first time in June 1951. The causal fungus was isolated by the writer from a dying red oak tree in a woodland in Cass County. A few other red oaks nearby were already dead, and the indications were that the disease had been present about 2 years in this location. The condition of the trees was called to the author's attention by Louis Miller, Farm Forester. The identification of the causal fungus was confirmed by Dr. T. W. Bretz, Division of Forest Pathology, U. S. Department of Agriculture.

In July an aerial survey of southern Michigan under the auspices of the State Conservation Department revealed many dying oaks. These were visited by ground crews from three cooperating agencies: the Division of Forestry, State Conservation Department; the Bureau of Plant Industry, State Department of Agriculture; and the Michigan State College. Cultures made by the author from typical cases showed the disease to be present in six additional counties: St. Joseph, Berrien, Calhoun, Jackson, Washtenaw and Oakland. The disease seems to have been present for about 5 years in some locations.

DISTRIBUTION

The present known distribution of oak wilt is in the following 16 states: Arkansas, Kansas, Illinois, Indiana, Iowa, Maryland, Michigan, Minnesota, Missouri, Nebraska, North Carolina, Ohio, Pennsylvania, Tennessee, West Virginia and Wisconsin.

HOSTS

All species of oak growing native in this part of the United States have been found to be susceptible, either by natural infection or arti-

Contribution No. 51-6 from the Department of Botany and Plant Pathology.

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ficial inoculation. In addition, several exotic species such as English oak and cork oak have been found to be susceptible (1).

CAUSE

The cause of this disease is a fungus, *Chalara quercina* Henry (3), which lives in the outer annual rings of wood tissue just beneath the bark. It may be found throughout the entire tree in the latter stages of the disease, from the leaf petioles to the roots.

It is known that this fungus will move through root grafts (5) from diseased to healthy trees of red and black oaks and cause the latter to sicken and die. How it travels to trees beyond the distance of root grafting is not known. This is one of the paramount problems that now confronts the investigators. All pathologists and foresters who have been working with this disease recognize that dominant and co-dominant trees in a forested area appear to be the first to be attacked. This suggests that birds, insects or tree-inhabiting rodents may be the vectors or carriers of the fungus from diseased trees to healthy trees some distance away.

SYMPTOMS

Symptoms of oak wilt are quite variable and may be confused with symptoms of other diseases of oak. In a new area where the disease has not been found previously, it is necessary to make a laboratory study of the diseased wood tissues, and to isolate and identify the causal fungus of oak wilt before making a positive diagnosis.

In the red or black oak group, the symptoms (4) are as follows: the earliest evidence of this disease is the pale, dull green discoloration, and curling of the older leaves. These leaves then become bronze to reddish brown and finally turn to a light tan. Heavy leaf fall may accompany the dying of the leaves and the ground will be covered with them, or they may hang stiffly downward on the tree indicating that a wilting has also occurred in the early stages of their dying.

This discoloration of the foliage is usually found in the top branches of the tree and at the terminal part of the affected branches.

Dying of branches progresses rapidly downward from the top of the tree, which may be dead within 2 months after symptoms first become apparent (Fig. 1). Sucker growth may develop on the trunk and main branches. The leaves soon wilt, turn brown, the young

leaves blacken and die. Brown streaking of the wood near or at the surface beneath the bark may be present.

In some cases trees may live over winter and put out a few leaves in the spring and then die. Seedling trees die very quickly after becoming infected.

Fig. 1. Red oak, showing rapid killing of tree from top downward. Discoloration of leaves in center portion of the tree is conspicuous.

Fig. 2. Oak wilt on bur oak, showing habit of killing individual branches on this host.

The spread of the fungus through root grafts accounts for the characteristic appearance of spot infection in a wood lot (Fig. 3). In the center the first tree infected is usually dead, often shedding bark, while in a concentric pattern about it are trees more recently killed. At the edge of the spot are the newly infected trees in various stages of dying.

Fig. 3. Spot infection by oak wilt in a red oak woodlot.

In white and bur oaks the disease does not progress so rapidly. The leaf symptoms are similar, but only a branch here and there in the tree is affected (Fig 2). Leaf fall is less common, and the leaves tend to hang on the twigs. Brown streaks in the last annual ring of the wood are more frequently found. Oak trees in this group may live two or three years after the disease becomes apparent. A stag-headed condition is common; however, this may also result from other causes and is not a reliable symptom.

CONTROL

Because of the limitations of knowledge concerning the behavior and transmission of the causal fungus, the ways to protect healthy trees from attack are not known.

From work done in Wisconsin (5) and Iowa (1), it seems possible that by prompt removal of infected trees, the spread of the disease can be slowed down or stopped. Killing by poisoning, or removal of all healthy oaks sufficiently near a diseased tree to permit root grafts, has stopped further spread of the disease in Wisconsin over a period of at least four years. Such control measures necessitate the removal of

all oaks within 100 feet. In felling diseased trees, care should be taken not to wound adjacent healthy trees. Brush should be piled on stumps and burned. This will prevent sprouting from the stumps. There is no evidence that removal of logs for sawing into lumber spreads the disease.

In white and bur oaks, where only a few branches are diseased, it seems possible from studies made in Iowa (1) that affected branches can be pruned out and the disease stopped entirely or at least delayed in its progress. Pruning tools should be disinfected with denatured alcohol after cutting off diseased branches.

In cases where valuable ornamental trees are involved, trenching and cutting the roots between healthy and diseased trees will prevent the spread of the causal fungus. A cut 30 inches deep is considered sufficient to sever connecting roots.

Prompt action to eradicate diseased trees as rapidly as they are found will slow down or prevent the further spread of oak wilt. Otherwise, it will become a serious threat to a valuable group of trees which make up about 35 percent of our forested areas in southern Michigan.

OTHER COMMON OAK TROUBLES

Many other causes produce symptoms of disease in oak that may be confused with oak wilt. Some of these are listed below:

1. Anthracnose or leaf blight is common in white and bur oaks. In seasons favorable for the disease, the leaves turn brown to blackish and the tree may even be defoliated.

2. Browning of leaves on twigs throughout the tree is often caused by squirrels or oak twig pruner cutting off twigs so that they hang in the tree or drop to the ground.

3. Nutrient deficiencies in the soil produce a chlorosis or yellowing of oak foliage.

4. Leaf scorch may result from drought, mechanical injury to roots, or from calcium or sodium chloride salts washing from treated highway surfaces.

5. A stag-headed condition is often caused by a change in the soil water table, and by packing of the soil by grazing or parking.

6. Spring frost injury to foliage, wind breakage of branches, and lightning injury may all produce browning and death of leaves.

7. June beetles may attack red oaks in such numbers as to defoliate

trees in successive years and so cause their death. The periodic cicada or 17-year locust sometimes produce so many punctures that branches may be killed.

Since there are so many other causes of injury which may be mistaken for oak wilt, all oak trees exhibiting suspicious symptoms should be called to the attention of foresters in state, county or city organizations, the state nursery inspectors, or county agricultural agents who may be able to examine the trees to determine whether the symptoms are due to other causes.

If, after examination of trees, oak wilt is suspected, then suitable specimen material should be collected and mailed to the Department of Botany and Plant Pathology, Michigan State College, for laboratory study and diagnosis.

Pieces 6 to 8 inches long from dying branches, up to about 2 inches in diameter, are desirable. Do not collect dead branches since the fungus cannot be successfully isolated from them because of the "weed" fungi which grow readily in dead bark and wood. Pieces from dying sprouts can be collected. At least six pieces, not more than 2 of which are from the same branch will make a minimum sampling. Tie each set of samples securely together or place them in a cloth bag. Label each sample, giving it a number or letter, or the owner's name, and the location as to section number, township, and county. Send a letter giving the same information as given on each labelled set of branch (and sprout) pieces.

After collection, mail specimens promptly since the fungus, if present, cannot be isolated after a week to 10 days after removal from the tree. Do not allow sample material to lie where it will be subjected to high temperature, such as in closed automobiles in summer.

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THE MEASUREMENT OF QUALITY IN THE FUR OF MINK (*MUSTELA VISON*)*

By PATRICIA ELLIOTT WENTZ and H. R. HUNT
DEPARTMENT OF ZOOLOGY

THE DEVELOPMENT of mink and fox ranching during the past 25 years has created a definite economic need for a knowledge of the inheritance of fur quality. Selection for quality has been based on visual comparisons among furs relative to the judge's standard of perfection. Variations in individual standards and accuracy, as well as the number of factors involved in the concept of quality, have limited accomplishment in breeding for quality.

The purpose of this study has been to develop quantitative means for the measurement of some factors in mink fur quality as a foundation for further genetic research. The methods described in the paper will undoubtedly be improved with use by investigators and mink ranchers. The present study is only the first stage in the development of quantitative means for measuring fur quality. The long range purpose, of course, is to improve the breeders' selection for quality. Standard fur measurements should also be useful in determining the economic value of certain feeding or management practices.

THE FUR COAT OF THE MINK

Mink fur is composed of a dense, fine, insulating underfur protected from water and abrasion by longer, stiffer guard hairs. Hairs develop from epidermal follicles, each of which ordinarily produces one guard hair and from two to twenty-five fibers of underfur. Rarely, follicles produce only underfur fibers or only a straight guard hair (Fig. 1). Most of the straight guard hairs are accompanied by from two to not

*The authors are much indebted to Mr. Thomas Tiley, Secretary of the Michigan Fur Breeders Association, for his assistance; to Mr. Frank Gothier and Mr. David Loffman for judging some of the sampled mink, and to the following men who permitted the taking of fur samples from their animals: Mr. John M. Wozniak, Mr. R. W. Menzel, Mr. J. L. Sherlock, Mr. A. Hitchcock, Mr. L. C. Ramp, Mr. Perry Slack, Mr. Karl Kromer, Mr. Floyd Taylor, A. and J. Stuekerjuergen, and the Savage Brothers.

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Fig. 1. Types of guard hairs and underfur fibers of the mink.

more than eight underfur fibers from the same follicle, contrary to the findings of Hardy and Hardy (1942) who thought straight guard hairs always occurred singly in a follicle.

Underfur fibers have four to six crimps. Their cuticle (outer cell layer) consists of well-developed scales, and they are nearly constant in diameter below a slightly wider region adjacent to the tip. Guard hairs range from crimped, short ones, difficult to distinguish from underfur, to straight, coarse guard hairs. The shorter guard hairs are bent posteriorly at the outer surface of the underfur, with the shortest ones being the most bent. All guard hairs have a much greater diameter above the underfur than within it. The smaller the guard hair, the greater the number of underfur fibers coming from its follicle. The straight and the longer bent guard hairs comprise the coverage of the mink fur. In the current study, guard hair measurements were confined to them, although the shorter bent hairs, being quite numerous, may have their own effects on quality.

Pelt prices depend on the following factors:

1) *Primeness.* Primeness is of fundamental importance. The unprime pelt is deficient in all of the factors of quality, particularly depth, luster, and underfur color (shade). It does not "look" well or wear well, and is likely to shed. The winter coat becomes prime in late November or early December in the area of Michigan and Wisconsin. Mink are pelted at this time and breeding stock chosen. The skin is creamy-white, firm and thick. The fur is lustrous, showing "life" or "spring" when handled.

2) *Color mutations.* The market value of a color mutation depends largely on its scarcity. While the new mutation is still scarce, poor quality may be tolerated.

3) *General condition and size.* Guard hair tips damaged from exposure (singed), and pelts carelessly skinned and handled are much penalized. The larger male pelt brings a higher price.

4) *Quality.* The components of quality are the main determinants of pelt price. The other factors in pelt price (except color mutations) are important in so far as they affect quality. The factors that comprise quality, their definition, and the standard of perfection for each are detailed in the following table:

Component of Quality	*Definition*	*Standard*
Density.....	Number of underfur fibers per unit area....	As many fibers as possible
Depth.....	Length of underfur.....	Medium long (14 mm.)
Texture.....	Diameter of underfur (particularly) and guard hair	Medium fine
Length.....	Length of guard hair compared with underfur	$1^1/_3$ to $1^1/_2$ times the underfur length
Coverage....	Number and relative length of guard hairs..	Protection of underfur to optimum extent (balance)
Color.....	Underfur shade.....	Grayish blue
Luster.....	Reflection of light.....	Lustrous, oily

TECHNIQUES

Several methods of obtaining fur samples were tried. One method was to use a metal plate with a square opening of known area in the center. Dissecting needles and forceps were employed to isolate a square of fur for cutting by pulling it up through the hole. A second method was to form two separations of hair, 1 centimeter apart, across the fur with a pair of calipers. Glass slides were placed on the separations and clamped together while two other separations were made at right angles to isolate a square of fur to cut.

However, the use of small-sized hair clippers was the only method found to be feasible for living mink. A comb with one end carved to a

point was used to straighten and part the hair. Two samples were taken from each animal in what are considered to be the choicest parts of the pelt—one sample from the thoracolumbar region over the last ribs and lateral to the midline, and one sample over the hip. The length of the clipped strip was measured on each side with a short rule. The average of these two measurements multiplied by the width of the clippers gave the area of the skin from which each sample of fur had been taken. An approximately uniform length of 1 millimeter of fur was unavoidably left on the skin of the clipped area. When using this method of sampling, great care must be taken to prevent small losses from entanglement in surrounding fur, and from drafts, and to measure the length of the cut area when the mink has relaxed its skin. Samples were kept in individual, labeled envelopes.

The lengths and diameters of underfur fibers and guard hairs could be measured easily. But it was impossible from a practical viewpoint to determine the density by counting the number of fibers, for the fibers are very narrow and entangled objects. So, it was decided to weigh samples taken from a known area of skin to determine density.

A sample was first given an individual ether bath to remove fat and dirt. The sample was handled throughout with forceps. It was then dried on a glazed paper under an electric light bulb. Samples were weighed on a chain balance to 0.001 gram. Then the guard hairs were removed from the underfur with forceps, and the underfur and guard hairs were separately weighed. This separation could have been done more easily before the ether bath. Using the known area of the sample, the weight per square centimeter for both underfur and guard hairs was calculated.

The lengths of 20 straight guard hairs and of small staples of underfur were measured with a steel rule, on a white background and with good light. Small staples (or groups) of underfur fibers were extracted with forceps and measured, since it is difficult to obtain an accurate measure of the fragile underfur fibers singly. It must be remembered that the length measurements recorded in the tables are about 1 millimeter less than the actual lengths, since the clippers leave that much fur.

The diameters were measured with an ocular micrometer at 100 X magnification. Two measurements were made on each of 20 guard hairs selected at random—one in the uniform narrow part of the guard hair where it was surrounded by underfur and one in the widest part.

Care was taken to measure the greatest diameter as the hair is somewhat elliptical. Twenty or more width measurements per sample were made on the underfur. Widths were taken on a curving portion of the fiber where scaliness was well-developed.

Color was measured by matching samples against the standards of Ridgway (1912). Daylight, but not direct sunlight, is necessary for grading color.

RESULTS

One hundred and eighty-four samples were taken from 92 mink. Sixty-eight of these samples from 34 mink were completely analyzed. A summary of the results of the measurements is presented in Table 1. In Table 2 is shown the relationship between these measurements and age, sex, color, and the averages for the animals of three breeders.

Underfur was 0.6 mm. longer on the side than on the hip. The underfur of males averaged 0.9 mm. longer than that of females. Though females' samples were not so long, the length ratio (guard hair/underfur) was better—1.73 as compared with the males' 1.83. The guard hair of the 9 two- and three-year-old mink averaged 1.0 mm. longer than that of the 16 one-year-olds. Various breeders had said this would be the case. Both underfur and guard hairs were shorter on the samples taken in the late fall than in the spring, indicating that the hair was still growing in the fall. The wild mink from southern Michigan had a good underfur length, but the length ratio was 1.97. The length ratio of the color mutations was also high.

Male underfur and proximal guard hair width was, as expected, greater than in females (Table 2). The wild mink had very coarse underfur and guard hair measurements as compared with other samples studied. The show samples were finer in texture than the average.

Both underfur and guard hair from the sides of animals weighed more than that on the hips. The correlation between underfur weights for hip and side samples from the same animal was + 0.830. The same correlation for guard hair weights was + 0.716.

Table 1—Summary of measurements

Measurements	Hip samples				Side samples				Average of hip and side samples			
	Underfur staple	Guard hair		Ratio g.h./u.f.	Underfur staple	Guard hair		Ratio g.h./u.f.	Underfur staple	Guard hair		Ratio g.h./u.f.
Length in mm. (clipped sample 1 mm. less than on live animal)												
Average	12.6	23.2		1.84	13.2	23.3		1.77	12.9	23.3		1.81
Standard deviation	±1.2	±2.4			±1.1	±3.0			±1.0	±2.2		
Range	11–15	19.5–27			10–15	15.5–30			11–14.5	17.75–28.50		
	Underfur	Guard hair			Underfur	Guard hair			Underfur	Guard hair		
		Proximal	Distal	Average		Proximal	Distal	Average		Proximal	Distal	Average
Diameter in units (1 unit = 0.00091 mm.)												
Average	13.03	55.25	142.41	98.83	13.13	54.84	143.94	99.39	13.08	55.04	143.18	99.1
Standard deviation	± .44			±4.68	± .59			±3.90	± .38	±3.42	±6.02	±4.04
Range	12–14	48–63	128.5–155		12–15	47–63	133–156					
	Underfur	Guard hair		Total	Underfur	Guard hair		Total	Underfur	Guard hair		Total
Weight in gm. (per sq. cm. x 10,000)												
Average	162.5	64.4		226.9	175.8	73.1		248.9	169.2	68.8		238.0
Standard deviation									±23.2	±11.3		±31.9
Range	113–213	35–92		157–289	117–223	55–98		182–310	134–213	46–95		191–283

TABLE 2—Relationship of age, sex, color, and breeder to measurements

		Total average	Age		Sex		Breeder				Spring	Fall	Color mutations
			1 yr.	2-3 yrs.	Male	Female	A	B	C	Wild			
Number of samples		68	32	18	46	22	18	14	14	2	48	20	18
I *Length* (mm.)	Underfur staple	12.9	13.0	12.8	13.2	12.3	13.1	12.7	13.1	14.5	13.0	12.6	12.7
	Guard hair	23.3	23.0	24.0	24.2	21.3	23.4	23.5	23.6	28.5	23.7	22.3	24.3
II *Diameter* in units (1 unit = .00091 mm.)	Underfur	13.1	13.1	13.0	13.1	13.0	13.1	13.1	13.1	14.0	13.1	13.0	13.0
	Guard hair proximal	55.0	55.1	55.3	56.2	52.7	53.6	55.2	57.7	62.0	55.5	53.7	53.9
	Distal	143.2	142.5	143.9	142.8	143.9	140.3	144.7	145.1	153.5	143.5	142.3	141.1
III *Weight*, uncorrected (gms. per sq. cm. x 10,000)	Underfur	169.7	170.1	172.9	175.5	156.1	178.7	168.7	171.7	192.0	173.9	156.3	161.3
	Guard hair	67.3	62.6	73.6	69.1	65.0	62.8	67.9	68.3	83.0	63.7	67.7	67.4
	Total	237.0	232.7	246.5	244.6	221.1	241.5	236.6	240.0	275.0	237.6	224.0	228.7
IV *Coefficient of Density*	Underfur	167.0	165.1	169.3	167.7	165.5	170.4	161.5	167.1	149.0	165.9	169.6	163.0
	Guard hair	71.6	66.6	76.1	69.7	76.3	68.0	70.0	68.4	60.0	68.4	79.2	70.8
	Total	238.6	231.7	245.4	237.4	241.8	238.4	231.5	235.5	209.0	234.3	248.8	233.8

COEFFICIENT OF DENSITY

The weight per square centimeter of fur is not a sufficiently accurate indicator of the fur density. In addition to the total number of guard hairs and underfur fibers in the sample, the other variables in determining weight per square centimeter are mass per unit volume, diameter, and length of both underfur fibers and guard hairs. Therefore, a correction must be made for fiber length and width before weight can be used as a measure of density. It has been assumed in this study that the mass per unit volume is the same for all the types of fur examined.

The coefficient of density for the underfur or guard hairs of an animal is the corrected weight of underfur or guard hair per square centimeter of skin $\times$ *10,000.* The corrected fur weights for the underfur, guard hairs, and total weights of a sample were calculated from the measured weights per square centimeter by correcting them to an arbitrary standard of 13 mm. for underfur length, 13 units on the ocular micrometer (0.01183 mm.) for underfur fiber diameter, 24 mm. for guard hair length, and 100 units (0.091 mm.) for the average of the proximal and distal guard hair diameters. These arbitrary standards approximated the averages for the fur samples studied. Of course, other standard values could be adopted. The corrected fur weights were multiplied by 10,000 merely for convenience in eliminating decimals.

The formula for the coefficient of density is

$$W_x = \frac{W_1 d^2 h}{d_1^2 h_1} 10{,}000$$

By considering the underfur fibers as a field of cylinders, this formula can be derived easily. The meanings of the symbols used are as follows:

W_x = Coefficient of density of a particular mink.

W_1 = Underfur weight per square centimeter of skin surface of the sample being corrected.

W = Standard weight of underfur per square centimeter of skin surface.

d = Standard underfur fiber diameter, 13 units or 0.01183 mm.

d_1 = Average underfur fiber diameter in the sample being corrected.

h = Standard underfur staple length, 13 mm. for clipped samples.

h_1 = Average underfur staple length of the clipped sample being corrected.

n = Standard number of underfur fibers per square centimeter of skin surface.

n_1 = Number of underfur fibers per square centimeter of skin surface in the sample being corrected.

m = Mass per unit volume of underfur.

The formula for the coefficient of density is derived in the following manner.

(1) $W = \pi\left(\frac{d}{2}\right)^2 h\ mn$ for the standard sample.

(2) $W_1 = \pi\left(\frac{d_1}{2}\right)^2 h_1\ mn_1$ for the sample being corrected.

(3) Therefore, $\frac{W}{W_1} = \frac{\pi\left(\frac{d}{2}\right)^2 h\ mn}{\pi\left(\frac{d_1}{2}\right)^2 h_1\ mn_1} = \frac{d^2\,h\,n}{d_1^2\,h_1\,n_1}$

If d_1^2 is multiplied by a correction factor, *a*, for diameter of underfur fibers, so that $d_1^2 a = d^2$, and h_1 is multiplied by a correction factor *b*, for length of underfur fiber, so that $h_1 b = h$, then $d_1^2 \quad \frac{d^2}{a}$, and $h_1 = \frac{h}{b}$.

Substituting in (3),

(4) $\frac{W}{W_1} = \frac{d^2\,h\,n}{\frac{d^2}{a}\frac{h}{b}n_1} = \frac{a\,b\,d^2\,h\,n}{d^2\,h\,n_1}$

(5) $\frac{W}{W_1\,a\,b} = \frac{n}{n_1}$

Since $W_1 ab$ is the weight of the underfur sample being considered corrected to a standard fiber diameter (d), and standard fiber length (h), then $W_1 ab = Wx$ (the coefficient of density) by definition.

$$(6)\quad \frac{W}{W_X} = \frac{n}{n_1} \cdot W = \frac{W_X\, n}{n_1}$$

Substituting in (3)

$$(7)\quad \frac{W_X\, n}{n_1\, W_1} = \frac{d^2\, h\, m}{d_1^2\, h_1\, n_1} \cdot \frac{W_X}{W_1} = \frac{d^2\, h}{d_1^2\, h_1}$$

$$(8)\quad W_X = \frac{W_1\, d^2\, h}{d_1^2\, h_1} \cdot *$$

The same formula may be used to compute the coefficient of density for guard hairs, Wy, by allowing d to be the standard guard hair diameter, set at roughly the average between the proximal and greatest widths (100 units or 0.091 mm.), and h to be the standard guard hair length (24 mm. for the clipped samples). W_1, d_1, and h_1 are the guard hair weight per unit area of the sample to be measured, the average guard hair diameter of the sample, and the average length of the guard hairs, respectively. Guard hairs are oval in cross-section for most of their length. If the ratio between the major and minor diameters is constant, the formula for the coefficient of density based on a circular cross-section can be used for an elliptical cross-section.

The average coefficient of density for the underfur is 168 ± 18.2. The range for the average of the hip and side samples for an animal is from 135 to 213. The average coefficient for the hip samples is 163.8 ± 20.5 as compared with the average for the side samples 172.2 ± 25.8. The coefficient of density for guard hair averaged 68.3 ± 14.3 for the hip samples, 77.1 ± 16.2 for the side samples and 72.7 ± 13.3 for the average of these two values (Table 3). However, the objective of this paper is not to determine the various values for any one group of ranch-bred mink, but to **explain and illustrate a method** for determining such values.

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*The same formula is correct if the cross section of a fiber is an ellipse with a major axis *d*, providing there is a constant ratio between the major axis and the minor axis, *c*. The area of the cross section of such an ellipse would be $\pi \frac{d}{2} \frac{c}{2}$. Let $c = ed$. Therefore the area is $\pi \frac{d}{2} \frac{ed}{2}$ or $\pi e \frac{d^2}{4}$. Equation (3) thus becomes $\frac{W}{W_1} = \frac{\pi e \frac{d^2}{4} h\, m\, n}{\pi e \frac{d_1^2}{4} h_1\, m n_1} = \frac{d^2\, h\, n}{d_1^2\, h_1\, n_1}$.

TABLE 3—Coefficients of density

Animal	Hip samples			Side samples			Average—hip and side		
	Underfur	Guard hair	Total	Underfur	Guard hair	Total	Underfur	Guard hair	Total
1	136	55	191	150	69	219	143	62	205
2	182	65	247	161	71	232	172	68	240
3	168	68	236	222	82	304	195	75	270
4	145	52	197	*	*	*	145	52	197
5	153	55	208	202	80	282	178	68	246
6	163	66	229	190	65	255	177	66	243
7	181	88	269	185	71	256	183	80	263
10	*	*	*	135	52	187	135	52	187
11	146	58	204	*	*	*	146	58	204
12	145	58	203	152	61	213	149	60	209
13	151	44	195	193	90	283	172	67	239
14	145	73	218	173	96	269	159	85	244
15	168	57	225	151	65	216	160	61	221
16	213	86	299	212	70	282	213	78	291
17	163	73	236	145	70	215	154	72	226
18	154	74	228	151	64	215	153	69	222
19	177	54	231	172	57	229	175	56	231
20	157	57	214	154	58	212	156	58	214
22	162	76	238	140	62	202	151	69	220
23	175	89	264	179	96	275	177	93	270
24	152	56	208	223	105	328	188	81	269
25	164	67	231	161	75	236	163	71	234
26	157	71	228	133	63	196	145	67	212
27	169	79	248	190	92	282	180	86	266
28	173	96	269	188	116	304	181	106	287
29	218	98	316	186	89	275	202	94	296
30	180	57	237	†	†	†	180	57	237
31	113	46	159	195	72	267	154	59	213

TABLE 3—Continued

Animal	Hip samples			Side samples			Average—hip and side		
	Underfur	Guard hair	Total	Underfur	Guard hair	Total	Underfur	Guard hair	Total
32	175	87	262	139	72	211	157	80	237
33	151	67	218	187	96	283	169	82	251
34	177	78	255	152	101	253	165	90	255
Average	163.8	68.3	232.1	172.2	77.1	249.3	168.0	72.7	240.7
6	±20.5	±14.3		±25.8	±16.2		±18.2	±13.3	±27.7
Range	(113-218)	(44-98)	(159-316)	(139-223)	(52-116)	(187-328)	(135-213)	(52-106)	(187-296)

*Weight not recorded—much too great from skin tension or measurement error.
†Not good sample—sampling poor or loss when taken.

DISCUSSION

DENSITY

A comparison was made between the coefficients of density and available breeders' and judges' estimates of density in the same animal. The average of the coefficient of density for the hip and side underfur samples of each animal presented the best agreement. This comparison is shown in Table 4. Only mink 32 seems to be seriously misplaced by the coefficient of density. The average total coefficient (underfur average plus guard hair average of the hip and side samples) gives nearly as satisfactory results for each animal. Deviations from breeder-judge statements are small; they can be explained by the inaccuracies of "naked eye" observation and by the difficulties encountered in securing the samples, particularly the side samples.

The weight of a sample is by itself an unreliable indication of density (see Table 2). The underfur weight of female mink was 156.1; that of male mink, 175.5. But the coefficient of density for females was 165.5, and for males 167.7. The underfur weight for fall samples was 156.3, and that for spring samples was 173.9, but the coefficients of density were 169.6 and 165.9, respectively.

The coefficient of density seems to be a reliable index of fiber number, suitable for scientific and practical use. Samples should be taken with particular attention to fur primeness, sample location, and measuring of the clipped area while the skin is relaxed. Since the variation in underfur fiber diameters is not great, there is some doubt that it

would be necessary, for ranch purposes, to make the correction for d, the fiber diameter.

TEXTURE

The underfur diameter as measured with the ocular micrometer agrees very closely with the judges' estimates on texture (Table 4). A rank of 2—that is, between 12.6 and 13.4 units (0.0115 and 0.0122 mm. diameter) is considered ideal since neither an over-fine, easily crushed, nor a coarse, hairy underfur is desired. Mink 22 had coarse guard hairs that perhaps influenced the breeder to judge its pelt as coarse. Probably that of mink 7 seemed finer because of the fineness of the proximal guard hair. The use of the underfur diameter to measure texture seems valid.

DEPTH

The ruler gives a quick and accurate measure of underfur staple length. The longer staple is more desired. A staple length of 14.5 mm. or more (13.5 mm. on the clipped samples) is considered very good.

LENGTH RATIO AND COVERAGE

The length ratio is the average guard hair length for a sample divided by the average underfur staple length. On the whole, this is a satisfactory measure of coverage. It will be recalled that about 1 millimeter of fur is left on the skin when the sample is secured. Also, the breeder does not include the fine tip of the guard hairs in his visual estimates of the length ratio, as we have done in our measurements. Under these circumstances, it seems that desirable measured length ratios are 1.75 or less. In the comparisons with visual estimates (Table 4), the calculations agree with two breeders but differ from breeder B. The authors believe that the error was, in this instance, on his part.

Not enough work was done with coverage to reach any conclusions.

COLOR

The use of Ridgway's color chart to grade underfur colors seems to be better than diagnosis by ordinary comparisons. The exceptional case might be an expert working under very constant conditions. The grayer underfur shades are preferred since they display both fur and wearer to the best advantage. The breeder-judge statements on grayness and brownness were confirmed by the grading with the Ridgway

TABLE 4—Comparisons of measurements with judges' statements

Density						Texture						Length ratio					
178 or higher 168 – 177 Less than 168		(1) Most desirable (2) Medium (3) Fair or poor				12 – 12.5 units 12.6 – 13.4 units 13.5 or higher units		(1) Too fine (2) Right (3) Too coarse				1.75 or less 1.76 – 1.90 1.91 –		(1) Most desirable (2) Medium (3) Long			
Animal number	Origin	Breeder's or judge's comment	Rank	Coefficient of density*	Rank	Animal number	Origin	Breeder's or judge's comment	Rank	Underfur diameter	Rank	Animal number	Origin	Breeder's or judge's comment	Rank	Length ratio	Rank
1	A†	Good	2	143	3	1	A	Fine	2	13	2	1	A	Short +	1	1.7	1
2	A	Very good	1	172	2	2	A	Fine	2	13.25	2	2	A	Short	1	1.73	1
3	A	Very good	1	195	1	3	A	Fine	2	12	1	3	A	Short	1	1.72	1
4	A	Good	2	145	3	4	A	Medium fine	2 –	14	3	4	A	Medium	2	1.85	2
5	A	Very good	1	178	1	5	A	Medium	3	13.5	3	5	A	Short	1	1.62	1
6	A	Good +	2+	177	2+	6	A	Fine	2	13	2	6	A	Short +	1	1.75	1
7	A	Very good	1	183	1	7	A	Fine	2	13.5	3	7	A	Short	1	1.84	2
25	Show	Not as good	3	163	3	12	Wild	Medium coarse	3	14	3	12	Wild	Long	3	1.97	3
26	Show	Medium	3	145	3	21	B	Fine	2	13.25	2	21	B	Short	1	2.12	3
27	Show	Very good	1	180	1	22	B	Medium coarse	3	13	2	22	B	Medium	2	1.94	3
28	Show	Fair	2	181	1	23	B	Fine	2	12.75	2	23	B	Short	1	1.98	3
29	Show	Very good	1	202	1	33	Show	Good	2	12.75	2	33	Show	Too long	2–3	1.90	2–
30	Show	Above average	2	180	1	34	Show	Fine	2	13	2	34	Show	Right	1	1.69	1
31	Show	Not as good	3	154	3												
32	Show	Good	1	157	3												
33	Show	Heavy	2?	169	2												
34	Show	Heavy	2?	165	3												

*Average of hip and side underfur coefficients for each animal.
†Letters refer to breeder.

color chart. The comparison is shown in Table 5. The authors were able to prepare a grading chart by fastening to paper 10 swatches of fur representing the underfur shades in the dark mink. Such a chart can be used more rapidly than one consisting of colored strips of paper, and is easily made from Ridgway's colors.

APPLICATION OF QUALITY MEASURES TO GENETIC RESEARCH

Quantitative measures of each component of quality will be necessary in genetic research. The authors believe that when securing the samples and measuring them are carefully done, the methods developed in this investigation are more specific and accurate than an expert's grading. The methods cannot compete, of course, with the speed of a judge in obtaining a quick over-all impression of an animal.

The measures may be used singly or as part of an index of quality, such as the following tabulation:

Factor	*Standard of perfection*	*Perfect score*
Coefficiency of Density.. (underfur average)	Above 167; particularly above 177.....	40
Depth.....	14.5 mm. or more (13.5 clipped).....	15
Length Ratio.....	1.75 or less, clipped sample.....	15
Texture (underfur).....	12.6 to 13.4 units (0.0115 to 0.0122 mm.).....	10
Color (underfur).....	Mouse gray, hair brown (Ridgway).....	20
Total quality.....	.....	100

The use of the quality measurements outlined should make possible the following improvements in the breeding, feeding, and merchandising program on the mink ranch: a) accurate comparison between samples from live mink for more accurate culling; b) assignment of specific grades based on an index of quality, for use in production records over a period of years; c) an opportunity to breed for a single trait or combination of traits without confusion with other traits; d) accurate comparison of an individual mink or ranch with the quality of fur production in the entire industry; and e) comparison between hereditary and environmental effects.

TABLE 5—Comparison between breeders' descriptions of color with grading by the Ridgway color chart

Dark mink only were graded. A rank of 1 indicates the better colors.

Animal	Time sampled	Statement of color by breeder		Measurement by Ridgway color chart	Rank*
		Verbal	Rank		
1	Spring	Good	1	Clove brown	3
2	Spring	Good	2	Clove brown	3
3	Spring	Good	1	Fuscous	1
4	Spring	Fair, dihybrid		Cinnamon drab	2—
5	Spring	Medium	3	Clove brown, closest	3
6	Spring	Good	1	Fuscous	1
7	Spring	Good	1	Fuscous	1
Wild	Spring	Good, light	2	Benzo brown	2
Two Tone	Spring	Good	1	Hair brown	1
35	Spring	Poor	4	Rood's brown	4
36	Spring	Poor	4	Bone brown	3
37	Spring	Slate, extra dark	1 or 2	Benzo brown	2
25	Fall	Hybrid, good	1	Mouse gray	1
26	Fall			Fuscous	1
27	Fall			Bone brown	3
28	Fall			Dusky drab	2—
29	Fall			Fuscous	1
30	Fall			Bone brown	3
31	Fall	Hybrid, good	1	Mouse gray	1
32	Fall			Fuscous	1
33	Fall	Extra dark, past prime	2	Dusky drab	2—
34	Fall	Extra dark, good	1	Hair brown	1
Pelt 2		Medium slate, good	1	Hair brown	1
Pelt 4		Light slate	2	Benzo brown	2
Pelt 6		Muddy, poor	4	Van Dyke brown	4

*Explanatory footnote is on following page (p. 64).

(Footnote to Table 5, p. 63).

*The mink underfur samples were matched with the painted colors of Ridgway's color charts (*Color Standards and Nomenclature*, A. Hoen and Co., 1912). These colors are the primary colors and their mixtures, pure and with the addition of gray and black. Samples from dark mink matched grayed colors with 58% to 95.5% gray added to the pure colors. Colors with 95.5% gray (mouse gray) or 90% gray (hair brown, fuscous, benzo brown, cinnamon drab, and dusky drab) were given ratings of 1 or 2. Bone brown and clove brown with 77% gray rank 3, while Van Dyke brown and Rood's brown rank 4 since they had only 58% gray.

The pure colors from which these grayed colors were made are mixtures of red and yellow. Colors with a higher percentage of yellow are better. Hair brown with 67.5% yellow is somewhat better than fuscous with 54.5%, though both of these rank (with mouse gray) as 1. Benzo brown and cinnamon drab with 54.5% yellow rank 2, while dusky drab with 40% yellow is enough poorer to be 2—.

If the percentages of gray and yellow are the same, the color with the more black is the better. Thus fuscous with 87.5% black is enough better than cinnamon drab and benzo brown to rate 1. Benzo brown with 45% black is a better shade than cinnamon drab with no black. Van Dyke brown with 87.5% black is better than Rood's brown with 70.5% black.

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WEIGHT LOSS ON DRESSING AND METHODS OF PROCESSING GAME FISH

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PRIVATELY OWNED ponds and small lakes serve many purposes, such as providing water for stock and irrigation, controlling erosion, and furnishing recreational facilities. Many of these water areas offer the possibility of producing and harvesting crops of fish for sport and food with small outlay of capital and labor.

The problem of how best to harvest, process, and utilize fish crops prduced in farm ponds was considered as part of a larger program of research and was carried out in cooperation with the Michigan Department of Conservation. Some of the fish were obtained from ponds at Wolf Lake State Fish Hatchery, Kalamazoo County, in southwestern Michigan. Six ponds had been stocked in June 1947 with largemouth black bass (*Micropterus salmoides*) and bluegills (*Lepomis m. macrochirus*), and fish from the ponds were harvested September 8-10, 1949. These two species are the most commonly utilized fish for farm ponds throughout the country and are, as well, the most popular game fish in Michigan. Brown trout (*Salmo trutta fario*) were obtained during a management and population study on a series of small trout lakes located in the upper part of the lower peninsula of Michigan. While the culture of trout in private ponds is not common practice in Michigan, Salia (1951), has shown that the production of trout in small ponds having water temperatures within the temperature tolerances of trout, has much promise.

Bullheads (*Ameiurus m. melas*) used in this study were harvested from experimental ponds located at Hastings Fish Hatchery, Barry

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[2]In cooperation with Michigan Institute for Fisheries Research.

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County, Michigan, at approximately the same time as the other fish. It is possible to produce bullheads, whose flesh is held by many to be superior in quality to that of bass, in ponds that will not support game fish.

Immediately following the removal of the fish from the ponds, all fish of usable size were sharp-frozen at −20 degrees F. in a local locker plant without having been processed in any way. Larger fish were wrapped individually in freezer paper and smaller ones were wrapped in groups packaging about three pounds. They were then taken to Michigan State College where they were held at 0 degrees F. until processed.

As time permitted, one or more packages were removed from the freezer and permitted to thaw only as much as was necessary for processing. They were processed, rewrapped in packages of meal-size, and placed back in the freezer which was held at a constant temperature of 0 degrees F.

METHODS

FREEZING

Local freezer plants and home freezers have made possible preservation of fish in the fresh state where formerly they had to be processed at once by drying, salting or canning. Several of the deep-sea fishing industries now sharp-freeze their catches immediately upon capture and later the fish are thawed, processed, and refrozen to await sale. It was thought possible to use this same method on fish harvested from farm ponds.

PROCESSING

Before processing, all fish were weighed in grams and measured to the nearest tenth of an inch. All bluegills were pan-dressed by removing the scales, heads, entrails, and fins. All bullheads and some of the bass were pan-dressed in the same manner except that they were skinned instead of scaled. The remaining bass were filleted by a method similar to that of Dendy (1946). This method is shown in Fig. 1. It was found that the skin was removed from the fish more easily when frozen and there was less loss and tearing of flesh than when the fish were dressed immediately following capture. The trout were "rough-dressed" by removing the head and entrails.

By removing the skin of the bass, the fish flavor is considerably improved, and a taste that is objectionable to some people is eliminated.

Bluegills may be skinned easily while frozen, and this is the quickest way to process frozen fish for the pan or for frozen storage, although there is no objectionable taste associated with the skin of the bluegill and its removal is not so important as when processing bass.

SMOKING

As an alternate method of processing the fish, some of the bass and bullheads were smoked. Those fish to be smoked were first processed by removing gills and entrails and then immersing in a curing brine consisting of 4 pounds of salt, 1½ pounds of sugar, and 1½ ounces of saltpeter, to 6 gallons of water. Fish were kept in the brine from 24 to 36 hours. Air-dried apple wood from which the bark had been peeled was the source of smoke. The smoker used was of the blower and re-circulating type. The fish were hung from nails in cross pieces located near the top of the smoker. Smoking was started when the temperature of the smoker had reached 95 degrees F., and for the next 3 hours the temperature was not allowed to rise above 120 degrees F. The temperature was then allowed to rise for the last hour but was kept below 150 degrees F. When the smoker was opened, the fish were seen to have taken on a glaze and the meat of the bullheads had turned a salmon-pink.

The length of smoking time depends upon the size and species of the fish, with the smaller fish taking less time in both the brine solution and the smoker. While the smoker used in these experiments was a somewhat complex type, equally good results can be obtained by use of a very simple smoke house, such as that described by Sharp (1951). All of the fish so processed had good flavor, but the bullheads were quite superior, presumably because of their oily flesh. They are considered equal in flavor to the most expensive smoked fish.

RESULTS

YIELD

The average yield of fish of usable size from four ponds in this experiment was 195 pounds per surface acre. A minimum size for usable fish was considered to be 5 inches for bluegills, 6 inches for bullheads, and 8 inches for bass. Below this size the amount of edible meat did not seem to warrant the time necessary for processing. The yield of edible size fish per acre was as follows:

Pond	12	17	20	21
Pounds	195.9	121.4	309.0	155.0

The total yields from these ponds would include all of the undersize fish as well as the usable ones, and this would be considered the carrying capacity of these ponds. The carrying capacity is estimated to be about twice the yield of usable size fish. Pond 20 gave an actual

Fig. 1. Method of filleting bass.

1. A cut is made all along the back and going straight down alongside the dorsal fin.
2. A cut is made alongside the anal fin extending from the vent to the tail.
3. The skin is cut diagonally down from the anterior end of the dorsal cut to the vent.
4. Starting at the anterior dorsal edge, the skin is loosened and pulled back and off at the tail.
5. A cut is made just dorsal to the lateral line and extending to just beyond the ribs. From here the cut is angled down to the ventral cut (shown in No. 6).
6. The dorsal cut is deepened to extend down to the ribs. After the knife passes the last rib, it is pushed all the way through to join with the ventral cut.

Fig. 1. (Continued)

7. The fillet should separate from the fish in one piece if all the cuts have been made correctly.
8. Shows one side filleted and the fish from which the fillet was taken.
9. The same dorsal cut is made for the other side.
10. The skin is removed in the same manner as shown for the first fillet.
11. Shows knife being pushed all the way through the fish after passing the last rib.
12. Finished fillets and fish carcass.

total yield of 669 pounds of fish per acre which is exceptionally high for this locality.

WEIGHT LOSS IN PROCESSING

To help determine the amount of edible food produced in these ponds, weight loss in processing was checked and the data for this part of the study given in Table 1.

TABLE 1—Summary data on fish processing .

Species of fish	Number processed	Size range (inches)	Average size (inches)	Weight range (grams)	Average weight (grams)	Dressed weight* (percent)
Bluegills.....	1,019	5.0 – 9.7	5.8	30 – 315	64.4	49.9
Bass.....	276	5.6 – 13.7	10.5	33 – 631	312.7	51.8
Bass (fillets).....	145	5.6 – 13.8	12.3	39 – 649	454.0	30.4
Bullheads.....	349	5.5 - 10.5	8.4	38 – 290	155.3	40.7
Trout (rough dressed).....	1,032	6.1 – 14.7	9.8	37 – 513	162.9	68.3

*Dressed weights are given as percentages of the total weights of the fish.

The reciprocal of the dressed weight percentages would be the weight loss in processing. The figures for bluegills and pan-dressed bass compare well with the findings of Tack (1944) on the dressed weight of carp and suckers which he lists as 53.7 percent and 52.9 percent, respectively, of the live weights. Tack's findings were for fish which retained the caudal fin. A few bass and bluegills were pre-

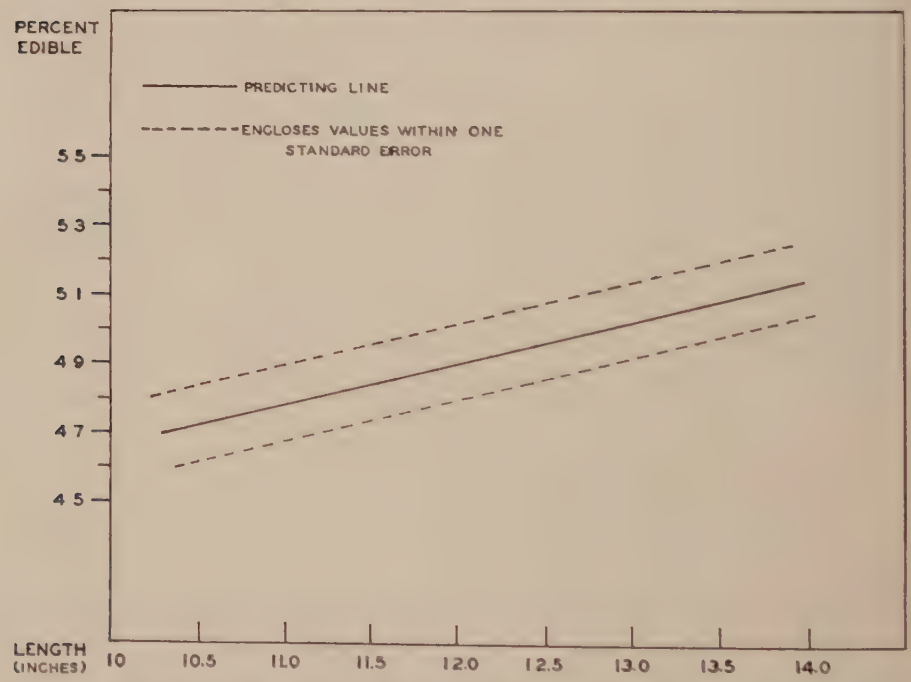

Fig. 2. Relationship between length of largemouth bass and loss of weight in processing.

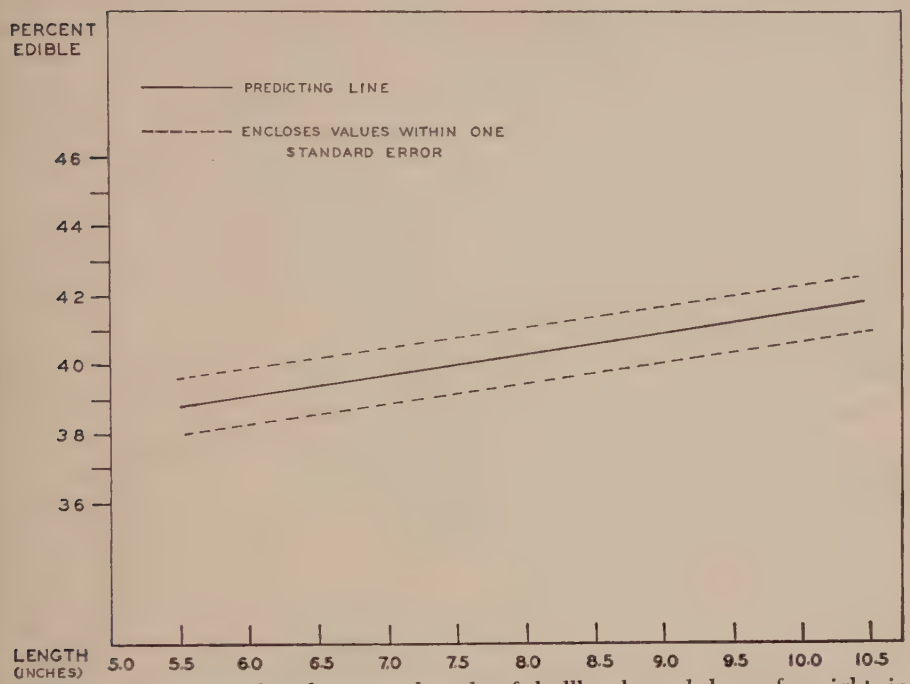

Fig. 3. Relationship between length of bullheads and loss of weight in processing.

pared in such manner, and it was estimated that this added about 1.5 percent to the dressed weights.

The bluegills showed a loss of approximately one-half of the live weight when pan dressed. There seems to be only slight variation in the percentage of loss between the large and small fish.

In preparing fish for smoking, it was found necessary to draw only the entrails and remove the kidney and gills. The drawn weight for bass and bullheads was found to be about 90 percent of the total weight. A weight shrinkage of approximately 14 percent was found to occur during the smoking process.

The time needed to prepare large fish is not appreciably greater than that for small fish. Also, small bass, bullheads, and trout, showed a slightly greater percentage of weight loss in processing than did the larger fish. This is shown graphically in Figs. 2, 3, and 4. Larger fish can be filleted nearly as rapidly as they can be pan dressed. Fillets take up less freezer space and, owing to the absence of bones, are highly preferable.

The work of processing these fish extended over a 3-month period. Following processing the fish were returned to zero storage and sam-

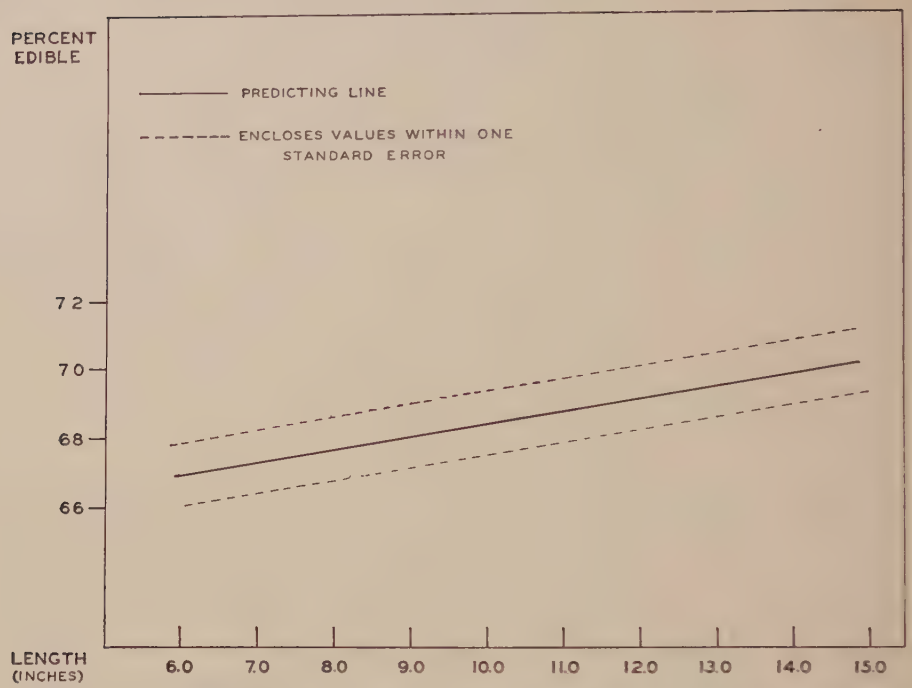

Fig. 4. Relationship between length of brown trout and loss of weight in processing.

ples taken at intervals to evaluate keeping quality. At the end of a year in storage the quality seemed to be good in nearly all packages, although this exceeds the length of time generally recommended for storage of fish.

At the time the fish were taken from the ponds, a few fish of each species were kept apart and these unprocessed fish checked for taste quality at the end of 9 months. They seemed to be of excellent quality at the end of the period. This suggests the possibility of storing fish in the round (unprocessed) until needed and then preparing for table use.

A few of the processed fish showed slight drying or "freezer burn", owing probably to poor packaging. Freezer paper used should be tough enough to avoid breaking and should be moisture and vapor proof (Bratzler, 1950).

COMPARISON WITH BEEF AND POULTRY

In comparing the weight of fish harvested per acre of pond to the number of pounds of beef or poultry that an acre can support, one

should remember that these fish were not fed, while most cattle and poultry are given a considerable amount of feed over and above that supplied by the range.

In the southern part of Michigan it is customary to range from 125 to 150 head of cattle per section of land. This averages from four to six acres per animal. With good pasture, two to three acres should be sufficient. A steer will gain about 250 pounds on the grass each season. In two seasons there would be a gain in weight of 500 pounds for the animal for each two to three acres. About 500 pounds of corn and 500 pounds of hay or roughage are required to put 100 pounds of beef on feeder calves.

The average live weight of all cattle slaughtered for beef between the years 1930 and 1945 was 944 pounds. The average dressed weight was 55 percent of the live weight. The percentage varied from prime steers, which dressed out at 62 - 67 percent, to cutters and canners which dressed out at 40 - 52 percent of the live weight (Ziegler, 1945).

No comparison of production in terms of pounds per acre can be made between fish and poultry. As many as 400 - 500 pullets may be kept on one acre, but they cannot be maintained without feeding. At the present time, it costs around 25 cents to raise one pound of broiler. Feed represents about 70 percent of this cost. About 3.5 pounds of feed is required for each pound of broiler produced. The amount of feed that can be saved by pasture is 10 - 15 percent. Dressed broilers lose 33 percent of their live weight. Turkeys lose about 25 percent. This dressed weight consists of bone as well as meat, and only about 40 percent of a broiler's live weight can be considered edible.

If no supplementary feed were given, the yield of beef per acre would vary from 166 to 250 pounds under ideal conditions. The fish from Wolf Lake ponds showed an average yield of 195 pounds per acre. As for the usable percentage, cattle are slightly higher, with dressed weights averaging 55 percent as compared with 50 percent for pan-dressed bass and bluegills.

Supplementary feeding would be necessary when raising poultry. If it will save 10 - 15 percent of feed cost, pasturing is a means of saving 1½ to 2 cents a pound on the cost of production. However, the owner would still be paying about 23 cents a pound for his broilers, and that is considerably more than the fish would cost him.

These data are included as a basis for comparing the production of well known protein sources, such as beef and poultry, with the production of fish. While under our present laws it is not possible to sell game fish reared in farm ponds, the production of these fish can well serve to supplement the diet with high quality protein produced at low cost and harvested and processed at small expense.

Many ponds, if properly managed, can produce an annual crop of edible fish with a minimum of effort. The crop can be harvested throughout the year and utilized immediately, or harvested at one time and processed for future use.

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DETROIT EGG PRICES AND CANADIAN EGGS

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POULTRYMEN in Michigan and other border states have become concerned that the imports of eggs from Canada have depressed egg prices in their markets. During the last two years Canada has become a substantial contributor of eggs to the Detroit market, particularly during several months of the year. This article brings together data on imports, exports, prices and production which provide a basis for appraising the price effect of imports. Other material is provided on government price support operations and the extent to which a sometimes proposed embargo on egg imports might have reduced expenditures for this purpose.

In 1949 Canada ranked fifteenth as a supplier of eggs to Detroit, and in 1950 she climbed to sixth. However, rank does not clearly indicate the relative importance since Canada supplied only 2 percent of the total shell eggs marketed in Detroit in 1950. The relative importance of the various contributors is illustrated by the data in Table 1.

TABLE 1—Origin of receipts of eggs at Detroit, 1950

Origin	Cases	Percent of total
Michigan	564,617	40.6
Ohio	457,250	32.9
Minnesota	101,478	7.3
Illinois	76,367	5.5
Indiana	68,916	5.0
Canada	31,551	2.3
Wisconsin	29,395	2.1
Iowa	21,653	1.5
Other states	38,695	2.8
Total receipts	1,389,922	100.0

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From this table it is readily discernible that seven states and Canada, for all practical purposes, are the suppliers of eggs on the Detroit market. From this group, Michigan and Ohio contribute nearly three-fourths of the total, and thus would exercise the greatest price determining effect. The others, however, can exercise a marginal effect, either singly or combined, on supply and prices and thus cannot be overlooked. Canada is in this latter group of suppliers which the authors have chosen to refer to as marginal suppliers.

IMPORTS SMALL FRACTION OF PRODUCTION

It might be wise to consider briefly the relationship of Canadian eggs to the entire United States poultry industry and price program. This is necessary because any controls imposed on egg imports will be national in scope and, thus, should be based primarily upon an over-all need, if such exists. In Table 2 are shown United States production, government purchases, and Canadian shipments of eggs in the post-war years, 1945-1950. All physical quantities are in millions of dozens which causes some difficulty in handling the smaller quantities, but it is necessary if one is to grasp the relative size of the various items without a constant reorientation of thinking from column to column.

It should also be emphasized here that the percentages in column six and seven are fractions of 1 percent. Hence, Canadian shipments

*TABLE 2—Production, government purchases, and Canadian shipments of eggs, 1945-50**

Year	Farm production	USDA purchases	USDA egg exports	Canadian shipments	Canadian shipments as a percent of		U. S. farm price
					Production	USDA purchases	
	million dozen	million dozen‡	million dozen‡	million dozen‡	percent	percent	cents
1945	4,878	...	430	1.56	0.032	....	37.7
1946	4,641	304	364	0.06	0.001	0.02	37.5
1947	4,600	276	220	0.13	0.003	0.06	45.3
1948	4,496	81	133	0.37	0.008	0.45	47.2
1949	4,698	213	68	2.15	0.045	1.01	45.1
1950†	5,004	245	159	4.50	0.090	1.84	42.6

*Compiled from Poultry and Egg Situation, U. S. Department of Agriculture.
†Preliminary.
‡Shell egg equivalents: 10.1 pounds dried whole eggs = 30 dozen shell eggs.
37.5 pounds frozen whole eggs = 30 dozen shell eggs.

in 1950 were only 0.0009 — nine ten-thousandths — as large as domestic farm production. When compared with government support purchases, Canadian egg shipments are also very small, being less than 2 percent.

However, the important things to consider in trying to find the cause of price changes are the relative changes in the various components of the total egg supply and in the outlets for the eggs produced. In the period, 1948-50, when the U.S. farm price of eggs declined about 4½ cents per dozen, Canadian shipments increased about 4 million dozen. Domestic production of eggs increased approximately 508 million dozen, or about 125 times greater than the increase in imports. The effect of increased Canadian shipments on over-all prices is insignificant, by comparison.

Moreover, during the period 1945-49, United States egg exports declined steadily from 430 million dozen to 68 million dozen, rising to 159 million dozen in 1950 as government-purchased dried eggs were dumped in foreign markets. Increases in Canadian egg shipments also are small by this comparison.

Therefore, on the national or total egg price picture, Canadian eggs are relatively insignificant as a price determinant. Increases in egg production and decreases in exports are far more important. From the viewpoint of conserving government funds, only a little over one million dollars of the eighty-odd millions spent on egg price support would have been saved if a complete embargo had been in effect.[1] Under these circumstances there seems little reason to impose quotas from a national egg price viewpoint. Furthermore, the repercussions of counter measures by Canada and implications of these in other segments of the economy seem to be far greater than any benefit derived from a quota.

WERE DETROIT PRICES AFFECTED?

Despite the results of the foregoing analysis, the question as to whether Detroit is subject to price pressures not evident in the aggregate picture remains to be answered. Does the Michigan egg producer depending on the Detroit market receive lower prices for his eggs than producers using other market outlets? If so, is this due to Canadian eggs?

[1]Imports of dried eggs from China are not considered in this statement since none are currently being received from Communist China.

Price pressures on individual markets might result from an unequal distribution of Canadian eggs in the United States markets. Of the 13 egg markets whose annual summary of the origin of receipts was considered, only four reported Canadian eggs in 1950:

Detroit	31,551 cases
Chicago	8,368 cases
New York	7,683 cases
Boston	5,523 cases

Thus, it is evident that Detroit receives the major share of the Canadian eggs. Buffalo probably receives as many Canadian eggs as Detroit, as both markets are similarly located with respect to Canadian producing areas. However, data for Buffalo are not available for comparison. Transportation costs are largely the reason for the concentration of Canadian marketing in the above-mentioned markets.

The movement of Canadian eggs into Detroit by months, with the corresponding monthly prices, is given in Table 3. From this data it is not readily discernible what effect Canadian shipments of eggs have on Detroit prices. Indications point to little or no relationship between Canadian eggs and the resultant monthly price at Detroit. For instance, in the 15 months that Canadian eggs were present in the

TABLE 3—Detroit prices and Canadian egg shipments, 1948, 1949, and 1950

Month	1948		1949		1950	
	Canadian eggs at Detroit	Price*	Canadian eggs at Detroit	Price*	Canadian eggs at Detroit	Price*
	cases	¢/doz.	cases	¢/doz.	cases	¢/doz.
January	.....	48.06	72	48.07	13,149	32.00
February	.....	48.36	169	43.91	...	32.60
March	.....	48.52	58	45.88	140	38.10
April	.....	48.51	149	48.68	...	36.55
May	.....	46.56	.....	48.31	...	32.60
June	.....	49.59	.....	51.42	340	34.14
July	.....	53.12	.....	50.06	263	42.29
August	.....	58.57	.....	61.53	480	46.10
September	.....	61.74	2,344	65.08	...	53.50
October	.....	68.43	3,117	59.55	...	58.11
November	.....	68.13	2,535	52.25	529	58.10
December	2,113	54.48	.....	38.21	16,650	59.46
Total	2,113	.....	8,444	.....	31,551	.....

*Extras, large white.

Detroit market, prices declined seven of those months and increased during eight months. It is difficult, therefore, to discover from this data the relationship of Detroit prices to Canadian egg shipments.

The difference in prices between Detroit and Canadian markets does have a definite effect upon the flow of Canadian eggs into Detroit. The exact limits of this price difference cannot be ascertained from the limited data available. However, in Table 4 is found a summary of the price differences between Montreal and Detroit for grade A, large eggs during 21 months of 1949 and 1950. Table 4 shows that out of 13 months in which prices at Montreal were greater than those at Detroit, Canadian eggs were at Detroit only four months. When De-

TABLE 4—Price differences between Montreal and Detroit markets, and Canadian egg Receipts at Detroit*

Price difference (−) Montreal higher (cents per dozen)	Number of months with indicated price spread 1949-50	Canadian shipments to Detroit were	
		Present	Absent
Up to −4.5	4	..	4
−4.5 to −3.5	3	1	2
−3.5 to −2.5	4	2	2
−2.5 to −1.5	1	1	..
−1.5 to 0	1	..	1
0 to 1.5	6	5	1
1.5 to 3.5	0	..	..
3.5 and up	2	2	..
	21	11	10

*Grade A, large.

troit prices were higher than Montreal, Canadian eggs were on the Detroit market seven of the eight months.

It should be pointed out here that there is little difference in the cost of transportation from the Canadian producing region, being about the same to either Detroit or Montreal. Hence, such things as the tariff and other governmental regulations are about the only factors that will alter the effect of price differences. The tariff was reduced in 1947 and is low. Since devaluation the profit on the exchange transaction largely pays the duty. Of course, if there were no tariffs the possible exchange profit would encourage additional imports.

Another method which may be used to determine whether Canadian eggs adversely affected Detroit prices is to compare price differences between Detroit and other United States markets. Prices of eggs in New York and Boston should normally be approximately the Detroit price plus the cost of transport between these two cities. The reverse should hold true for price differences of Detroit as compared with Chicago and Cincinnati.

Thus, if Canadian shipments were a serious price-determining factor on the Detroit market, Detroit should be in an unfavorable price position when Canadian eggs arrive in large quantities and in a favorable price position when Canadian eggs are absent. No evidence is available to substantiate this point.

TABLE 5—Price differences between Detroit and indicated other United States markets as related to Canadian receipts at Detroit, 1947-50

Price differences* between Detroit and New York. (−) Detroit price higher (cents per dozen)	Number of months with indicated price difference 1947-50	Canadian receipts in Detroit were	
		Present	Absent
−3.5 to −2.5	5	..	5
−2.5 to −1.5	1	..	1
−1.5 to − .5	1	..	1
− .5 to .5	5	3	2
.5 to 1.5	13	5	8
1.5 to 2.5	10	4	6
2.5 to 3.5	3	2	1
3.5 to 4.5	6	..	6
4.5 and up	1	..	1
Total	45	14	31
Detroit-Chicago price differences* (−) Detroit price higher			
More than −3.5	6	1	6
−3.5 to −2.5	4	1	2
−2.5 to −1.5	9	6	3
−1.5 to − .5	9	1	8
− .5 to .5	10	5	5
.5 to 1.5	6	1	5
1.5 to 2.5	2	..	2
2.5 and up	2	..	2
Total	48	15	33

*Extras, large white.

Note: With a large minus figure, Detroit prices were favorable as compared with those of the other markets, while a large positive figure shows that Detroit prices were depressed relative to the other market.

Table 5 summarizes the price differences between Detroit and New York and between Detroit and Chicago. From this table it can be seen that Detroit egg prices are favorable and unfavorable with respect to other United States markets whether Canadian eggs are present or not. This is further exemplified by the fact that when prices are the most and the least favorable to Detroit, Canadian eggs are almost completely absent. Thus, factors other than Canadian egg imports seem to determine whether Detroit egg prices are high or low relative to other markets.

The cost of transportation and such things as local laws and regulations will, of course, also govern the flow of Canadian eggs to the United States markets. The reason that Canadian eggs are not always present when prices at Detroit are the most favorable with respect to other United States markets, is because the over-all Canadian-American price relationship is not always conducive to the flow of eggs into the United States at those times.

Attention must also be given to the position of Detroit in the national egg price. Since eggs from Ohio, Minnesota, Illinois, and other midwest states by-pass other midwestern markets and shun eastern markets to flow into Detroit, it is clear that those eggs would move to other markets if Detroit prices were depressed. If heavy shipments of Canadian eggs depressed Detroit prices, the effect would be the same as larger supplies of eggs from Michigan sources. Out-state shippers would send their eggs to other markets. In view of the relative importance of out-state shippers and the limited total amounts of Canadian supplies, it is difficult to conceive of a prolonged price depression on the Detroit market. Detroit cannot be divorced from the national price picture.

The data available for this study did not permit testing the idea that Canadian shipments on a particular day or week depressed Detroit prices temporarily for a few hours or a day or two. Substantial quantities of eggs arriving unexpectedly would tend to lower prices below the normal relationships. This would be true of eggs coming from any source. The data analyzed above show that such price effects, if any, from Canadian egg shipments did not persist long enough to affect the average monthly price at Detroit compared with other markets.

SUMMARY

Canadian shipments of eggs in the postwar years have never exceeded nine-hundredths of 1 percent of United States production. The increase in Canadian shipments since 1948 is only a fraction of a percent of the increase in United States production of eggs. Price declines between 1948 and 1950 were due primarily to increases in domestic production, decreases in export outlets, and to changing levels of government price supports.

Analysis of price differences between Detroit and Montreal prices shows that Canadian eggs move to Detroit when Detroit prices are higher than Canadian prices regardless of the level of Detroit prices. There is no indication that Canadian eggs have forced an unfavorable relationship between Detroit and other competing United States markets. It was not possible to compare daily imports of Canadian eggs with daily price changes to determine whether any very short-time temporary price effects could be detected.

A complete embargo on Canadian eggs would not materially affect Detroit prices. It would have saved no more than about one million of the eighty-odd million dollars spent on egg price supports. Further, it might have set in motion a series of retaliatory measures by Canada which would have adversely affected other sectors of agriculture and cost in the aggregate more than the money saved by embargoing a relatively small amount of eggs.

HATCHABILITY OF PUREBRED AND CROSSBRED CHICK EMBRYOS

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SUMMARY

THIS REPORT is presented to answer a general question: "Do crossbred embryos hatch better than purebred ones from the same hens?" The question is of interest in view of the general doctrine of hybrid vigor among plant geneticists.

In brief, the results of the experiment reported herein indicate that crossbreeding does not increase the vigor of the chick embryos as expressed by ability to hatch. Actually, the crossbred embryos were slightly less vigorous, but the difference was not statistically significant.

The pure breds used were Dark Cornish and White Leghorns, and the cross was made both ways, i.e. reciprocally. The data indicate that, on the average, the dam has much more influence on the hatching power of her embryos than their sire. This seems quite logical since the dam contributes virtually all the food material in her eggs and is responsible for the kind of shell they have. There were none out of seven pairs of pens in which both of the sires definitely improved the vigor of the crossbred embryos.

The rest of the report contains experimental and statistical proof of the answer to the question propounded above.

INTRODUCTION

According to data in process of publication (1), a significant increase in hatching power was found from the first to the ninth genera-

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tion of a population of Dark Cornish chickens. During some of the years of the 9-year period the chick embryos in the eggs were sired exclusively by Cornish males. In other years, Cornish and Leghorn males were alternated at 2- to 7-day intervals in the Cornish breeding pens in order to get purebred Cornish and Leghorn x Cornish half-sibling brood mates[1] in equal numbers.

The question which arose (in view of the existence of the doctrine of hybrid vigor, heterosis) was whether hatchability was improved by cross breeding in the years that cross matings were made. Because of a significant progressive increase in hatchability during the 9-year-period, regardless of whether the embryo chicks were sired by Cornish or Leghorn males, the report does not yield an answer to the question. Apparently, from the results of the study mentioned above there was not a breed difference between sires in their influence on embryonic vitality or ability to hatch.

There is little evidence in the literature (2, 3) of functional Xenia, via the genetic contributions of the sperm to the embryo in the egg. Waters (4) postulated a sire influence on hatchability as the result of diallel crossing within a single breed (White Leghorns) from a subsequent statistical test for general significance. It is not clear from Waters' report how much time elapsed between matings and the setting periods of the two matings, or whether the parent stock had identical environments. It is generally known that variations in hatchability between sets are common with no change of sire. Some of the variation among hatches may be attributed to environmental factors. If comparison of genetic influences is desired, the various populations should have the same environment, unless the experiment is designed to account for environmental influences.

A statistical test for general significance by analysis of variance merely indicates whether the sample is homogeneous or heterogeneous. To test the differences between categories, such as different sires or genotypes, Snedecor (5) suggested a paired technique which seems more adequate for such purposes.

OBJECTIVE

The objective of the study reported herewith was to determine the variation of the influence of sires of different breeds on the hatchability of eggs which were "seasonal brood" mates.

[1]The term "seasonal brood mates" is used to designate all the eggs from one hen during one hatching season.

A procedure which should be nearly ideal for measuring differential influences of sires on hatchability of eggs would be to get approximately equal numbers of eggs by two different sires in the same settings from individual hens, and incubate them simultaneously in a common incubator. Some bias may exist in this procedure because it is not considered possible at present to distinguish the ancestry of embryos which die at early ages. It would be necessary to save the eggs from individual hens a reasonable length of time before incubation; consequently, the embryos in the eggs from the different sires would be of different ages when incubation began. Since it is not possible to distinguish embryos in eggs according to sire, a compromise procedure was adopted.

GENERAL PROCEDURE

In 1947 some cross matings were made in a way that permitted the determination of the ancestry of eggs in adjacent "broods". In most instances the (Cornish and Leghorn) pens at this station were mated in the early part of the season to get purebred chicks, after which the pens were reciprocally cross-mated to get crossbred chicks. Males were reversed by breeds immediately after a certain setting date so that all eggs from the first sets were unquestionably purebred, after which eggs of mixed ancestry were obtained, and set on the next setting date 2 weeks later. The eggs obtained in adjacent broods are designated as seasonal brood mates. The eggs immediately following the purebred mating were expected to contain a few purebred embryos but a larger percentage of crossbred embryos. In the second setting, 2 weeks after the males were reversed, virtually all the eggs contained embryos of determinate ancestry. In most instances the hatching performance of the eggs from the two adjacent sets of brood mates[2] was recorded. In no instance was the setting period more than 4 weeks apart for the different breeds, and approximately equal numbers of eggs were set from each hen in each period of comparison.

RESULTS AND DISCUSSION

The hatching performance of the eggs of the different breeds in 1947 is shown in Table 1.

[2]The term "brood" and "brood mates" are used to designate all the eggs from one hen which were set at one time in the same incubator.

TABLE 1—Hatchability of eggs from identical purebred dams mated alternately with sires of different breeds (1947)

Breed No.	Kind of mating	Number sires	Number dams	Number eggs set	Average percent hatched
1	Cornish.....	7	25	253	86
2	White Leghorn x Cornish.....	7	25	267	84*
3	White Leghorn.....	7	23	248	80
4	Cornish x White Leghorn.....	7	23	286	77*

*Difference in percentage hatch between breeds, 2 and 4 significant beyond P = 0.05 by the X^2 test.

The results are based on eggs of seven different lines or pens of purebred and crossbred matings. There were approximately 10 eggs from each hen, on the average, in each breed category. Twenty-five Cornish dams and 23 Leghorn dams were represented. Seven different Cornish and seven different Leghorn sires were used, one in each pen at a time. The lines in each breed are more or less related and more or less inbred, as described by Henderson (1).

The method of determining the average hatch in each line category is that of the average of the averages of the dams. In this way the influence of each dam is equalized and variation among dams may be determined.

The averages of the two purebred sets of eggs differ (86 and 80 percent) significantly by the X^2 test** and therefore they must be considered as different populations.

The principal objective of the analysis of these data was to determine the influence of cross breeding on the hatchability of eggs as compared with pure breeding. It is apparent in Table 1 that the purebred eggs hatched better than their crossbred seasonal brood mates. The White Leghorn sires depressed the hatchability of the Cornish dams by 2 percent, and the Dark Cornish sires depressed the hatchability of the White Leghorn dams by 3 percent. Neither difference is statistically significant by analysis of variance; therefore neither heterosis or functional Xenia is apparent.

In most cases the crossbred eggs were set later in the spring and had the possible benefit of any improved weather conditions. It was presumed however, that the confinement management system under which the birds were kept would equalize seasonal weather influences.

**P <.01

THE DAMS' INFLUENCE GREATEST

A predominant influence of the dams on hatchability of their eggs is suggested in the comparison of the reciprocal crossbreds. Eggs from Cornish dams by Leghorn sires hatched significantly better (84 and 77 percent) than eggs from Leghorn dams by Cornish sires.

Hatchability of the individual dams varied about equally between the two purebred and crossbred sires. As for the Leghorn x Cornish sets of pairs (of the 25 dams), hatchability was increased 10 out of the 25 cases by the cross-mating, depressed nine times, and in six cases there was no difference. Among the 23 Leghorn dams, cross-mating increased hatchability six times, depressed it twelve times, and had no effect four times. Among the sires when cross-mated, hatchability was increased twice out of seven matings and depressed in all the other instances. One particular Leghorn sire was very "prepotent" when mated to Cornish dams. The hatchability of this particular pair of reciprocally cross-mated pens is indicated, as follows: DC x DC, 67 percent; WL x DC, 82; WL x WL, 68; and DC x WL, 62.

The White Leghorn sire was able to produce only 68 percent hatchability from seven White Leghorn dams, but he was able to produce 82 percent hatchability from four Cornish dams. On the other hand, the Cornish sire was unable to increase hatchability in the same identical Leghorn dams.

In spite of the apparent heterosis attributable to the aforementioned Leghorn sire, the average from the seven Leghorn sires is lower than that of the seven Dark Cornish sires when mated to the same dams. Unfortunately, the "prepotent" Leghorn male died before he could be tested that same year with a larger number of females. The apparent outstanding performance may have been an example of "nicking" or of individual deviation normally expected in small samples and which is commonly obscured in averages.

STATISTICAL ANALYSIS

A complete statistical analysis of the data by the application of Snedecor's paired technique is indicated in Table 2.

It is apparent from the data in Table 2 that there is no significant difference between sires' influence on dams in hatching power. Hatching power seems to be matroclinous; it is influenced more by the dam than by the sire, which is quite logical. Crossbred embryos from Dark

TABLE 2

Source	D/F	S/Sq.	Mean Sq.
D.C. compared with W.L. x D.C.			
Discrepance.....	24	2,510	104
Hens (pairs).....	24	4,885	203
Breeds.....	1	67	67
	49	7,462	
W.L. compared with D.C. x W.L.			
Discrepance.....	22	759	34
Hens (pairs).....	22	9,645	438
Breeds.....	1	35	35
W.L. x D.C. compared with D.C. x W.L.			
Total 47	13,362		
Between 1	1,040	1,040	
Within 46	12,322	267	3.89 (4.05)*

* Required for significance.

Cornish dams hatched better than crossbred embryos from White Leghorn dams, but the difference is not quite significant at the 5-percent point. The ratio between mean squares is 3.89, but a ratio of 4.05 is required for significance by the usual convention.

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FARM PRACTICES AND EGG QUALITY: PART II PRODUCTION PRACTICES AFFECTING DECLINE IN EGG QUALITY

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THE EGG is a highly perishable product and may deteriorate rapidly if not given proper care between the time it is laid and the time it is consumed. The interior of an egg is not perfectly protected by its shell; hence, it is affected by environmental conditions. As a result, changes are continually taking place within the egg. These changes are controlled largely by external factors, principally, temperature and humidity.

Since the egg has its maximum quality as a food product when fresh-laid, it is advantageous for producers, handlers and consumers to provide optimum egg-holding conditions and to provide for rapid movement of eggs from producer to consumer.

A study of the factors affecting new-laid egg quality was reported by Dawson *et al.* in the Michigan Agricultural Experiment Station *Quarterly Bulletin*, February 1951. It was pointed out that definite seasonal variations were present in each of the factors affecting the quality of new-laid eggs, namely: albumen quality, shell quality, and incidence of blood and meat spots. Greatest differences in the quality of new-laid eggs were found to be due to breed and strain differences, to age of birds, and to environmental conditions, particularly temperature.

Even though a large percentage of all eggs produced are of good quality when laid they should be handled carefully and held under proper conditions. Because of differences in management and handling practices there is a wide variation in the level of egg quality

ARTICLE 34-12

among farms. Owing to these differences and since some egg buyers tend to pay an average price for all eggs, these buyers actually penalize the producers of high quality eggs and over-compensate the producers of low quality eggs. The operators of egg-grading stations who pay producers according to the quality of eggs purchased pay on a more equitable basis.

This part (the second) of a study of the quality of eggs produced on a sample of Michigan farms deals with some of the practices which may affect a change in egg quality after the eggs have been laid—especially during the first 24 hours. A general check on average quality (U.S. Grade) of eggs leaving each farm was made by analyzing egg-grading station records.

METHODS

A sample of two dozen eggs from each of 20 selected farms from three areas in Michigan was obtained each month during a one-year period. The period of time covered in the study was from May 1949 to September 1950. Although the initial visit to the farms in two areas was 4 months later than in the first area, results were tabulated according to calendar seasons so that variations due to age of birds and climatic conditions would be minimized.

All new-laid eggs were laid the day of the farm visit and were candled and broken out for interior quality measurements the same day. Day-old eggs were laid on the day previous to the farm visit and were broken out and observed on the day of the visit.

Each egg was candled and weighed before breaking. Shell conditions, visual Cornell Score,[1] computed Haugh Score,[2] and occurrence of blood and meat spots were recorded for each egg. A record of the farm practices which might affect a change in egg quality was obtained from each farm each month. (Some of those records were not complete enough to be used in this analysis.) Outside and egg room temperatures and relative humidities were measured during each farm visit.

FARM PRACTICES

SIZE OF FLOCK

The average daily egg production on the poultry farms in this study was 451 eggs, ranging from 59 to 1,073. Although these flocks,

[1]Cornell Score is a subjective measurement based on photographic standards for broken out egg quality. Smallest numbers represent best egg quality.

[2]Haugh Score is an objective measurement of quality based on thickness of firm albumen, with a correction applied for egg weight differences. Largest numbers represent best egg quality.

on the average, were larger than most Michigan flocks, a good distribution of management and egg handling practices were represented on farms with each size of flock. The daily production from each of eight flocks was fewer than 250 eggs. The daily production from all other flocks was distributed uniformly from 250 to 1,073 eggs (Table 1).

TABLE 1—Distribution of farms by average daily egg production

Number of eggs each day	Number of farms
Less than 250	8
250 – 499	4
500 – 749	4
750 and over	5

The number of times eggs were gathered each day remained about the same throughout the year. More farmers gathered their eggs twice each day than any other number of times.

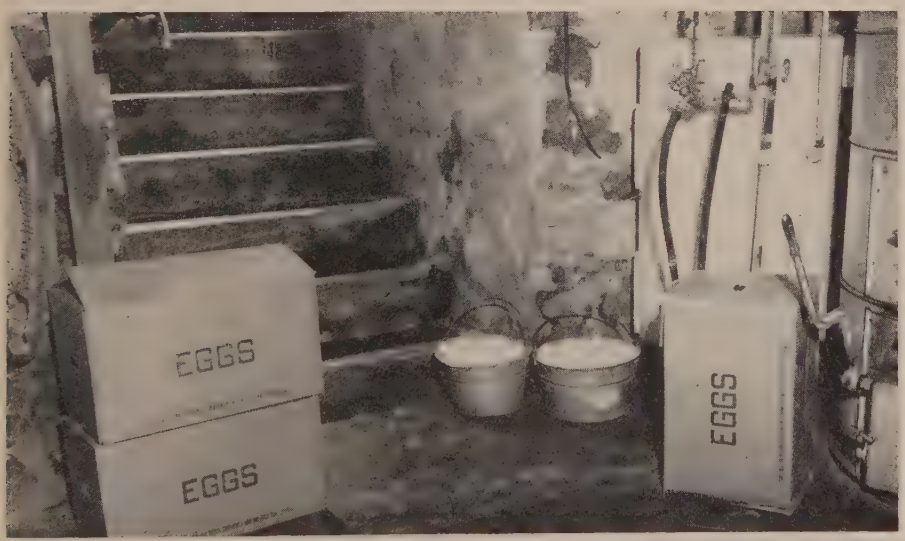

Fig. 1. One of the practices noted was that of gathering eggs in galvanized pails, and leaving them in a furnace room for several hours. Then the eggs were cleaned and either cased immediately or transferred to a wire tray for further cooling. Suggested improvements are: 1. Put eggs on tray as soon as gathered, and 2. Insulate egg room from furnace room.

EGG GATHERING AND COOLING EQUIPMENT

Eggs were gathered in wire baskets on 10 farms and in pails on 8 farms. Both wire baskets and pails were used on some farms, and a fiber basket was used on one farm (Table 2).

TABLE 2—Containers used for gathering and cooling eggs

Egg container	Container used for	
	Gathering	Cooling
	Number of farms	
Wire basket	10	8
Metal pail	8	5
Non-metal pail	1	1
Pail and basket	2	2
Wire tray	..	4
Egg case	..	1

Eggs which had been gathered in wire baskets were cooled in the baskets on eight farms. Eggs were cooled in pails on five farms, in a fiber basket on one farm, in wire trays on four farms, and were cased as soon as gathered on one farm (Table 3).

Fig. 2. Several farmers used wire trays for cooling and or drying eggs. For rapid cooling, eggs should be placed on such trays as soon as gathered.

EGG CLEANING METHODS

All eggs, whether clean or dirty, were washed on one-third of the farms, but only the dirty eggs were washed on three other farms. About one-fourth of the farmers brushed only the dirty eggs, and another one-fourth washed some and brushed some of their dirty eggs (Table 3). Only one-fourth of the farmers did not wash any of their eggs for market.

TABLE 3—Method of cleaning eggs on 20 farms

Cleaning method	Number of farms
Wash all eggs	7
Wash only dirty eggs	3
Brush only dirty eggs	5
Wash and brush dirty eggs	5

Fig. 3. Dirty eggs were brushed on a number of farms. This farmer found a comfortable spot for this tedious operation.

VARIATIONS IN EGG QUALITY

Since quality of egg shells and incidence of spots does not change after the eggs have been laid, only interior quality (albumen quality)

will be discussed here. Figure 4 shows the seasonal decline in albumen quality of new-laid and day-old eggs. Least amount of decline occurred in the winter, and greatest decline was found in the summer months.

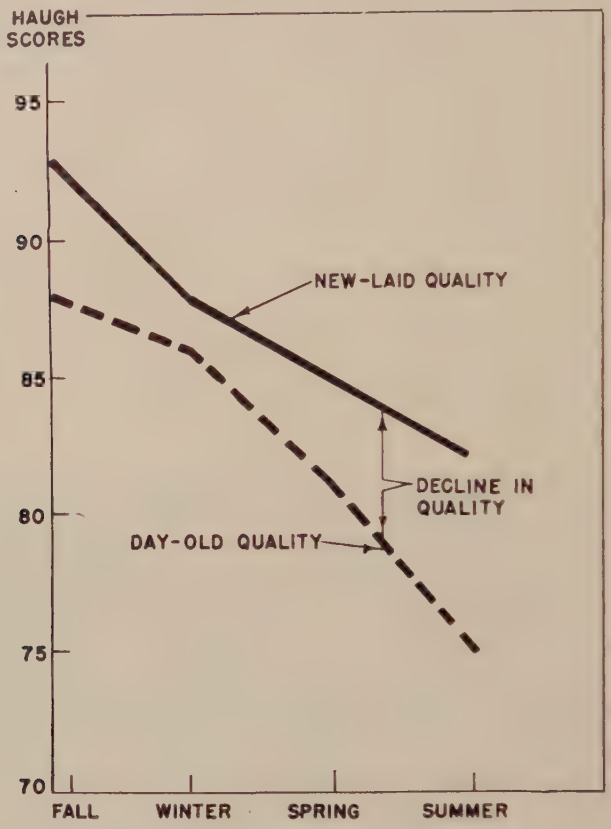

Fig. 4. Seasonal variation in the albumen quality of new-laid and day-old eggs.

Since the Haugh Score of albumen quality is the most accurate measurement taken, a frequency distribution of the scores of all new-laid and day-old eggs is shown in Fig. 5.

Seventy-four percent of all new-laid eggs had scores over 80. Only 57 percent of the day-old eggs had scores in this same range. Although the largest percentages of eggs had Haugh scores in the 80-89 group, a few eggs had scores over 100, and a small percentage had scores as low as 40. All eggs with scores over 55 should be marketed as grade A

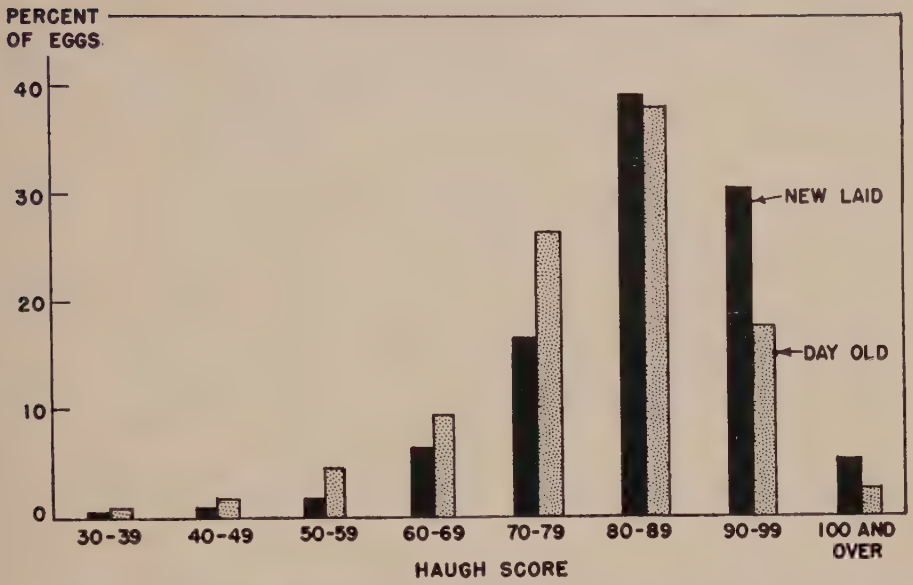

Fig. 5. Frequency distribution of Haugh scores of 2,527 new-laid eggs and 2,763 day-old eggs.

or better, provided other factors indicate A quality. Eggs to be graded AA should have Haugh Scores over 79.

HANDLING PRACTICES AND EGG QUALITY

FREQUENCY OF GATHERING EGGS

It is usually recommended that eggs be gathered at least twice a day in cool weather and three or more times a day in warm weather. Table 4 shows that the average 24-hour decline in quality for a year was greatest on the farms where eggs were gathered only twice a day (eggs were gathered two or more times a day on all farms in this study) and least on farms where eggs were gathered four times daily. On farms where eggs were gathered five times a day, decline was almost as large as it was on the farms where twice-a-day gathering was practiced. However, on all farms where eggs were gathered five times a day, the eggs were gathered in pails, and on one of these farms the eggs were cased as soon as gathered. In the summer, when albumen quality declined the most, the effect of frequent gathering on maintenance of quality (if any) was concealed by other factors. On the farms studied, the percentage of eggs laid on the floor and nest-broken eggs was apparently not affected by frequency of gathering the eggs.

TABLE 4—Relationship between frequency of gathering eggs and 24-hour decline in quality, annual average and summer average

	Number of times eggs were gathered each day			
	2	3	4	5
Annual Average				
Number of farms	6	7	2	4
Number of eggs per day	561	432	232	284
Percent "floor" eggs	1.7	1.7	1.4	1.8
Percent eggs broken in nest	1.0	1.3	1.9	0.8
New-laid quality (Haugh Score)*	85.0	84.0	87.4	84.7
24-hour decline (Haugh Units)†	4.5	1.8	0.7	4.0
Summer Average				
Number of farms	7	8	1	4
Number of eggs per day	416	328	425	284
Percent "floor" eggs	1.8	1.6	0.0	1.1
Percent eggs broken in nests	1.3	2.2	0.2	0.9
New-laid quality (Haugh Score)*	81.2	80.0	75.5	81.7
24-hour decline (Haugh Units)†	6.5	7.1	4.7	7.2

*Haugh Score is a physical measurement of albumen quality.
†Haugh Units represent the degree of difference in albumen quality between eggs or groups of eggs.

METHOD OF COOLING EGGS

As shown in Table 5, the loss in egg quality varies considerably throughout the seasons regardless of cooling method, with the greatest loss occurring in the summer. No one cooling method was superior to all others during every season. In the summer months when greatest loss in quality occurs the use of wire baskets or cooling trays resulted in better quality. The wide degree of variation within and among

TABLE 5—Relationship between method of cooling eggs and 24-hour decline in quality, by seasons

Method of cooling eggs	Case when gathered	Cool in wire basket	Cool in pail	Cool on wire tray
Number of farms	1	11	5	4
Albumen quality decline—Haugh units				
Fall	..	5	2	5
Winter	1	3	1	2
Spring	2	3	3	4
Summer	8	6	9	7

cooling methods was probably due to other egg handling practices. The temperature of the egg room and the time elapsed after the eggs were gathered and before they were taken to the cooling or storage room are important factors in maintaining egg quality.

METHOD OF CLEANING EGGS

In the summer and winter months, the washed eggs declined in quality the least; whereas, in the fall and spring months their quality declined the most (Table 6).

No one method of cleaning eggs resulted in either greatest or least loss in quality during all seasons of the year.

TABLE 6—Relationship between method of cleaning eggs and quality decline, by seasons

Method of cleaning eggs	Wash all eggs	Wash only dirty eggs	Wash some, brush some	Brush only dirty eggs
Number of farms	7	3	5	5
Albumen quality decline—Haugh units				
Fall	6	4	4	3
Winter	1	4	2	2
Spring	5	1	5	1
Summer	5	7	8	8

COMBINATION OF FACTORS

The desirable practices were considered to be:

1. Gather eggs three or more times each day.
2. Gather eggs in a wire basket.
3. Cool eggs in wire basket or tray.
4. Maintain relative humidity higher than that of sample average.
5. Keep egg room temperature lower than that of sample average.

TABLE 7—Effect of a combination of factors on egg quality decline, by seasons

	Number of farms	Loss in Haugh units			
		Spring	Summer	Fall	Winter
More than 2 desirable practices	10	2.75	4.95	2.06	3.43
2 or fewer desirable practices	10	5.08	8.60	4.08	5.20

Although little consistent relationship was found in egg quality decline within each of the management practices and environmental conditions, a marked difference was found by grouping the farms according to number of desirable practices followed. The eggs which were subjected to more than two desirable practices declined in quality only 60 percent as much as did the eggs from farms where the fewer number of desirable practices were followed.

Since egg producers are more interested in the grade of eggs marketed than some of the albumen quality measurements used in this study, grading station records from each of the farms in the study were analyzed for quality of eggs marketed. Records from the same farms for the same months covered in this study were sorted and analyzed by production and egg handling practices (Table 8).

TABLE 8—Number of dozens of eggs recorded on the gradingre cords analyzed, by seasons

Season	Dozens of eggs
Fall	13,375
Winter	14,264
Spring	10,907
Summer	10,203

It is usually believed that a higher percentage of top quality eggs are marketed from large flocks than from small flocks. Table 9 shows that the smaller producers in this study sold a larger percentage of grade A eggs than did the largest producers in every season. The smaller producers may have been able to consume most of their cracked, checked or dirty eggs; thereby they were able to market a higher percentage of grade A eggs.

TABLE 9—Relationship between egg production and percentage of Grade A eggs marketed, by seasons

Season	Average number of eggs per day			
	250 or less	250–500	500–750	Over 750
	Percent Grade A			
Fall	87.3	84.9	81.3	79.9
Winter	87.8	88.9	79.6	82.6
Spring	80.5	86.1	73.0	78.3
Summer	87.0	77.8	76.9	72.7

The percentage of grade A eggs marketed was greater in every season from the farms where eggs were gathered most frequently, (Table 10).

TABLE 10—Relationship between frequency of gathering eggs and percentage of Grade A eggs marketed, by seasons

Season	Number of times eggs were gathered each day	
	1–2	Over 2
	Percent Grade A	
Fall	81.5	85.1
Winter	82.8	85.4
Spring	79.4	79.9
Summer	75.4	79.1

As noted earlier (Table 6) the decline in quality during the first 24 hours after the eggs were laid was not consistently related to method of cleaning. As shown in Table 14, however, the farms where some eggs were brushed, or where only the dirtiest eggs were washed, marketed the highest percentage of grade A eggs in every season. The lowest percentage of grade A eggs was marketed every season from farms where all eggs or all dirty eggs were washed.

TABLE 11—Relationship between method of cleaning eggs and percentage of Grade A eggs marketed, by seasons

Season	Egg cleaning method			
	Wash all	Wash some	Brush and wash some	Brush some
	Percent Grade A			
Fall	80.7	81.2	88.2	84.5
Winter	83.0	74.4	91.0	87.3
Spring	78.4	70.2	89.2	81.4
Summer	72.7	78.4	86.4	80.1

The one farm where eggs were cased as soon as gathered marketed the highest percentage of grade A eggs every season except summer, and then the difference was only 0.2 percent. These eggs were brown shelled and may have been graded higher than the interior quality warranted (Table 12).

The percentage of grade A eggs marketed was lowest from the farms where eggs were cooled in a pail or were gathered in a pail and later (usually at night) transferred to a screen.

TABLE 12—Relationship between method of cooling eggs and percentage of Grade A eggs marketed, by seasons

Season	Container for cooling eggs				
	In case*	Wire basket	Pail	Wire screen from Pail	Wire screen from Basket
	Percent Grade A				
Fall	89.2	83.2	80.6	76.3	85.5
Winter	90.1	84.1	82.2	79.2	84.0
Spring	86.8	79.3	65.6	75.9	79.7
Summer	79.3	79.1	80.2	63.5	76.3

*This represents only one farm, marketing brown-shelled eggs.

It is usually suggested that farmers market their eggs at least once a week. Some farmers in this study marketed eggs every day, some three times a week, some twice, and some only once a week.

Table 13 shows the importance of frequent marketing. The farmers marketing eggs most often received payment for a larger percentage of grade A eggs every season. For the year as a whole they marketed 3.5 percent more of their eggs as grade A than did the farmers who marketed eggs least often.

TABLE 13—Relationship between frequency of marketing eggs and percentage of Grade A eggs marketed

Season	Most frequent marketing	Least frequent marketing	Difference
	Percent A	Percent A	
Fall	90.4	88.0	1.6
Winter	91.9	89.6	2.3
Spring	91.5	85.1	6.4
Summer	85.8	84.8	1.0
Year	90.7	87.2	3.5

DISCUSSION

FREQUENCY OF GATHERING EGGS

The act of gathering eggs several times a day does not insure any measure of albumen quality control, although it may result in fewer dirty or nest-broken eggs. The important consideration is to remove the eggs from a warm environment to a cool, moist, well ventilated environment so the contents of the egg can cool as rapidly as possible. Earle (1950) reported that independently the frequency of gathering eggs did not explain the variation found among farms in number of AA quality (candled) eggs, but it took a combination of factors to explain some of this difference. In a controlled experiment Skoglund and Tomhave (1941) reported a progressive deterioration in albumen quality when eggs were held 4, 6, and 8 hours at nest temperatures. However their variance due to experimental error was several times as large as the variance due to holding period; hence, their conclusions lack statistical significance. Results of the study reported here indicate that frequency of gathering eggs affects market quality (percentage of grade A eggs) more than it affects early 24-hour decline in albumen quality.

CONTAINER USED FOR GATHERING AND COOLING EGGS

Any container which is to be used for gathering or cooling eggs should permit circulation of cool air around the eggs in order that the body heat of the egg be removed rapidly. Funk (1935) reported the time required to reduce the temperature of an egg from a high temperature (93° to 102° F.) to below 68° F. in an egg room at 50° F. To reach this lower temperature, it took a single egg on a wire tray 1 hour; an egg in the center of three layers on a wire tray, 3 hours; an egg in the center of a wire basket of eggs, 5 hours; an egg in the center of a galvanized pail, 10 hours; an egg in the center of a chilled case, 18 hours; and an egg in the center of a warm case, 20 hours. Hence, if quick cooling is a prerequisite to quality maintainence, a wire tray or a wire basket should be used.

This study did not show a consistent relationship between method of cooling eggs and 24-hour decline in albumen quality. However, a larger percentage of grade A eggs was marketed from the farms on which eggs were cooled in wire baskets or transferred from wire baskets to wire trays than on farms where eggs were gathered in pails.

The reason why the eggs cased as soon as gathered were of such high candled quality is not clear. These eggs were brown shelled and were gathered five or six times each day; hence, only a few dozen were cased at any one time. The eggs were also packed large end up immediately after being laid. This may have affected their candled appearance.

METHOD OF CLEANING EGGS

Regardless of how careful a producer is some eggs become dirty before they are collected, and should be cleaned before they arrive in consumer channels of trade. Funk (1937) reported that the incidence of soiled eggs may be decreased by 50 percent by gathering the eggs four times a day.

Either wet washing, or cleaning by means of abrasives opens the pores of the shell. If the initial temperature of the egg is higher than that of the washing fluid, the fluid is readily drawn in through the pores by suction as the egg cools, and bacteria may enter with it. This condition may affect egg quality as measured in this study, depending on holding temperatures, but certainly would affect loss in storage. Bryant and Sharp (1934) concluded that there is no foundation for the common belief that washing in itself causes eggs to deteriorate if they are properly handled after washing. The deterioration of washed eggs is caused by bacterial infection of the eggs from the dirt that was on the shell. The only effective remedy is to prevent the eggs from becoming dirty.

Earle (1950) reported that method of cleaning did not affect the interior quality of eggs leaving the farm as determined by candling. Wettling and Burkart (1950) found that wet-cleaned eggs kept about as well as dry-cleaned ones. Wet-cleaning methods were preferable to dry cleaning methods because of less breakage, more thorough cleaning and a saving in labor. The study reported here, using smaller numbers of farms, showed considerable variation among cleaning methods each season. The decline in quality was neither greatest nor least in all seasons for eggs cleaned by any one method. However, a greater percentage of grade A eggs were marketed every season from the farms where eggs were brushed or a minimum number were washed—usually with a dampened cloth. Some of the drop in quality was probably due to the practice on some farms of leaving eggs in a pail until evening before washing them and then putting them on wire trays or in cases.

FREQUENCY OF MARKETING EGGS

The effect of time on interior egg quality is measured by frequency of marketing. It is usually recommended that eggs be marketed at least once a week and preferably twice a week in warm weather. Wilhelm (1939), using albumen index[3] as a measurement for albumen quality, reported that warm eggs subjected to temperature of 40° and 90° F. lost essentially the same amount of interior quality in 10 hours. After this early loss in quality, it took 8 days at 90°, 18 days at 70°, and 90 days at 50° for eggs to decline to the same quality level.

Lorenz and Newlon (1944) found that frequency of delivery to market was important, as demonstrated by the average loss in albumen height of ranch eggs of different ages. Eggs 5 to 7 days old had lost an average of 3.8mm; 4 day-old eggs 2.8mm; 3 day-old eggs 2.6mm; and 2 day-old eggs only 2.2mm. No measure of candled quality was reported, but candled quality is correlated with albumen height.

Since temperature and humidity are important factors in egg quality control the variation in quality decline among farms depends primarily on the environmental conditions under which the eggs are held.

SUMMARY

1. The quality of new-laid eggs was highest in the fall (pullet eggs) and lowest in the summer. This difference was due to age of birds and higher temperatures or a combination of these two factors.

2. Decline in quality (24 hours) was greatest in the summer months and least in the winter months.

3. Eggs gathered more than twice a day declined less in quality than those gathered less frequently. In the summer months the beneficial effect of frequent gathering was masked by other practices. The candled quality of all eggs marketed was highest from the farms where frequent gathering was practiced.

4. Eggs were cooled in pails, wire baskets (and in an egg case on one farm), and transferred from pails or baskets to wire trays. No one method was superior throughout the year because of variations in other practices. However, the use of wire baskets and wire trays resulted in a higher percentage of grade A eggs marketed every season and less decline in quality (24 hours) in the summer months.

[3]Albumen index of thick albumen is height ÷ width.

5. No one method of cleaning eggs resulted in either greatest or least loss in quality during the first 24 hours. However, the largest percentage of grade A eggs were marketed from the farms where the dirty eggs were brushed or only a few of the very dirtiest ones were washed.

6. The farmers who delivered their eggs most frequently marketed the highest percentage of grade A eggs.

Some of these practices would require additional labor and other incidental costs. No attempt was made to determine if the additional costs would be compensated for by the higher returns from better quality eggs. However, under most conditions, a little planning of the work routine and care of eggs will yield greater returns. Producing clean eggs and getting the eggs to a cool well ventilated place as soon as possible should result in higher returns to the producer and better acceptance by the consumers.

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FARM PRACTICES AND EGG QUALITY: PART III EGG-HOLDING CONDITIONS AS THEY AFFECT DECLINE IN QUALITY

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THE IMPORTANCE of preserving the quality of fresh-laid eggs cannot be over emphasized. The number of eggs consumed, the price received, and the costs of marketing are all affected by the quality of eggs marketed.

Biologically, only a new-laid egg is fresh. However, from a market viewpoint an egg may still be fresh 2 or 3 weeks after having been laid if properly handled and held under suitable environmental conditions.

Extension programs continually stress the desirability of having special egg rooms with provisions for maintaining some control over temperatures and humidities. However, it was found in a survey of over 200 poultrymen (Dawson and Davidson, 1949) that very few special egg rooms are being used. Why aren't farmers using more special egg rooms with cooling devices or humidifiers? Is it lack of convenience? Is it because of high cost? Or is it because returns are not increased proportionate to the cost of the rooms?

This experiment was designed to observe the effect of the actual temperatures and relative humidities of a number of egg-holding rooms on the decline in albumen quality and on the candled quality of eggs marketed.

Factors affecting quality of new-laid eggs and production factors associated with egg quality have previously been reported (Dawson and Davidson, 1951). The role of temperature and humidity in the egg handling rooms on these same farms will be discussed here.

PROCEDURE

The eggs used in this experiment were produced on 20 poultry farms marketing their eggs through federal-state egg grading stations. A sample of 2 dozen eggs from each flock was obtained each month

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for one year. Half of the eggs from 16 of the farms were laid the day of the visit and the remaining half were laid the day previous to the visit. The age of eggs obtained from four of the farms ranged from new laid to 4 days old. At the time of each farm visit the outside and egg room temperatures were measured. The outside and egg room relative humidities were measured with an air-aspirated psychrometer.

All eggs were taken to the same laboratory for quality observations. Egg weight, candled quality, visual score, and measured score were obtained for each egg.

As a further check on the variation in quality of eggs marketed from these farms the grading station records from each farm were obtained for all eggs marketed during the week of each farm visit. These records were analyzed on the basis of the candled quality of eggs sold.

RESULTS

EFFECTS OF TEMPERATURE

The average temperature in the 20 egg rooms for one year (reading once each month) was 63° F. One basement averaged as low as 50°, while the warmest one averaged 71°F. Figure 1 shows the seasonal variation and the range in temperatures. The greatest variation was found in the winter months when heating units affected some egg room

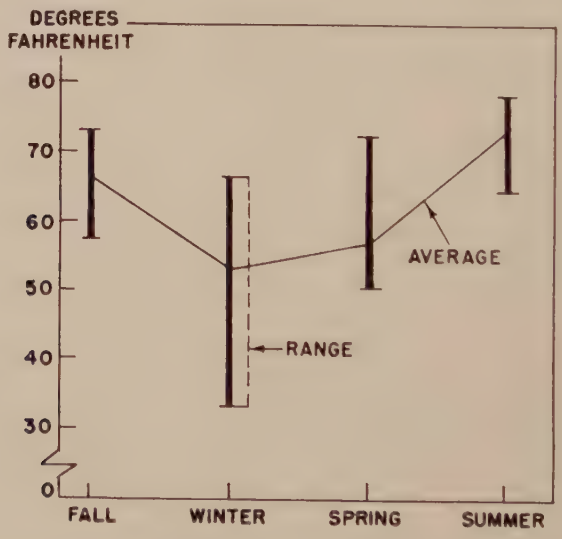

Fig. 1. Seasonal variation and range in egg room temperatures.

temperatures more than others. The average summer temperature of 73° F. was considerably higher than that usually recommended and was several degrees above the minimum temperature for fertile eggs to germinate. "Heat spots" on egg yolks may also develop in this temperature range.

Basement temperatures on 14 farms averaged about 1° F. lower than outside temperatures in the summer months, and were 23° F. higher than outside temperatures in the winter. Fall and spring egg room temperatures were 6° F. and 9° F. higher than outside temperatures (Fig. 2).

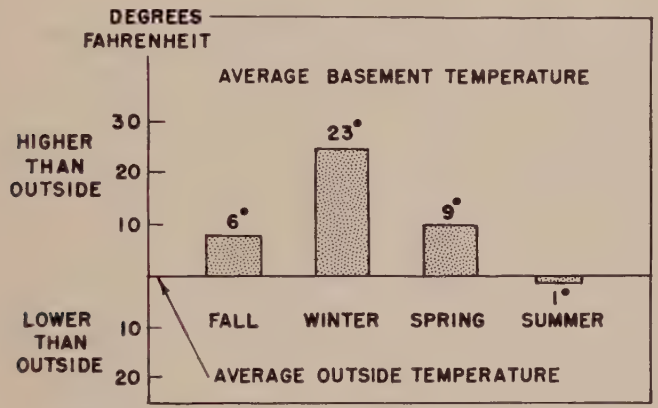

Fig. 2. Relationship between egg room (basement) temperatures and outside temperatures.

The effects of temperature alone on interior egg quality are shown in Table 1. In the fall, the farms with highest basement temperatures (average of 71° F.) lost an average of 3.9 Haugh Units[1] while those with lowest temperatures (average of 60° F.) lost only 1.6 units. In the winter and spring greatest loss again occurred on those farms with highest temperatures, but the least amount of quality loss occurred on the farms in the medium temperature range. In the summer months when the loss was greatest, the eggs held in basements of highest temperatures lost the most quality.

Using the average temperatures and changes in Haugh Units from Table 1, a regression coefficient of + 0.089 was calculated. This means that for every one degree increase in temperature, the egg quality

[1]"Haugh score" is an objective measurement of quality based on thickness of firm albumen with a correction applied for egg weight differences. Largest Haugh scores represent best egg quality. Haugh "units" as used in this paper indicate the difference between one Haugh score and another. In general, an AA quality egg should have a Haugh score of 80 or higher, and a C quality egg should have a Haugh score of 30 or less.

TABLE 1—Effect of egg room temperature on decline in egg quality

	High temperature		Medium temperature		Low temperature	
	°F. average	Haugh Unit loss*	°F. average	Haugh Unit loss	°F. average	Haugh Unit loss
Fall	71	3.9	67	3.6	60	1.6
Winter	62	5.2	53	2.8	44	4.6
Spring	63	4.5	58	3.8	51	3.9
Summer	75	7.0	74	6.7	70	6.6

*A large number of Haugh Units indicates greater loss in quality.

declined 0.089 Haugh Units in 24 hours. Since a number of variables were present, the data when plotted on regular graph paper showed considerable dispersion along the regression line. A significant correlation coefficient of + 0.494 was found.

In analyzing the grading records of the eggs produced from these same farms during the same week in which temperatures were recorded similar quality results were found. The farms where highest temperatures were recorded marketed the smallest percentage of Grade A eggs every season. Those where lowest temperatures were found marketed the highest percentage of Grade A eggs only in the fall and summer months. Very little difference was noted in percentage of Grade A eggs marketed from farms with low and medium temperatures except in the summer months.

TABLE 2—Relationship between egg room temperature and percentage of Grade A eggs marketed

Season	Low temperature		Medium temperature		High temperature	
	°F.	Percent Grade A	°F.	Percent Grade A	°F.	Percent Grade A
Fall	60	83.8	67	83.7	71	81.3
Winter	44	84.4	53	86.5	62	81.0
Spring	51	79.9	58	81.7	63	75.3
Summer	70	84.8	74	78.9	75	76.4

EFFECTS OF HUMIDITY

The average relative humidity of all egg rooms for the year was 54 percent. This average did not vary as much as did the temperature between seasons, but the humidity range within any one season was

greater than the temperature range (Fig. 3). Greatest variation in humidities among farms was found in the winter and spring months, probably owing to the heat supplied by some heating units. Eggs were held in house basements on most of these farms.

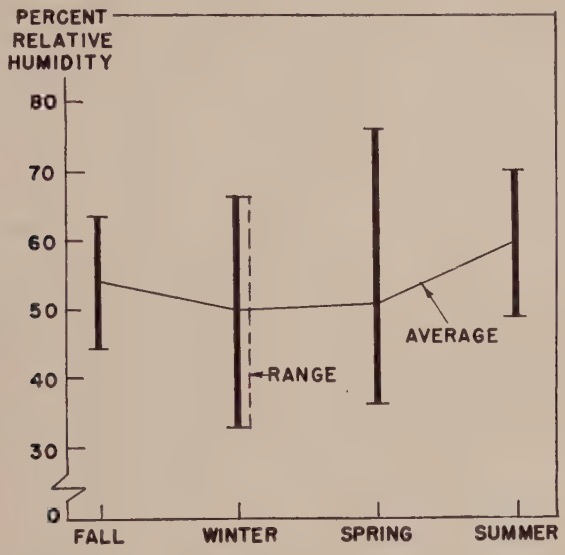

Fig. 3. Seasonal variation and range in egg room relative humidities.

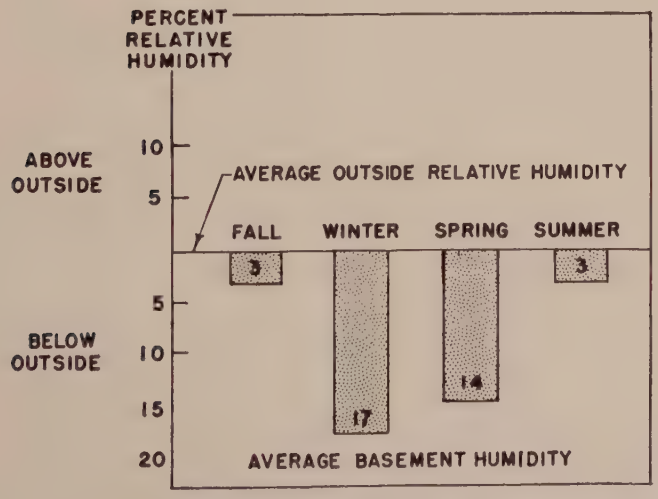

Fig. 4. Relationship between egg room relative humidity and outside relative humidity.

The average relative humidity of all egg rooms (14 farms) was below the average outside humidity in all seasons. When furnaces were being used in the winter and spring, basement humidities were 17 and 14 percent less than the outside relative humidity (Fig. 4).

Relative humidity, within the limits of existing conditions in this experiment, had no consistent effect on controlling loss in albumen quality. The eggs held under conditions of low humidities declined the least in quality in the fall and winter but the most in the spring. Those eggs held in rooms with highest humidities declined more in quality than those held in either the medium- or low-humidity rooms in any season (Table 3). The correlation coefficient between average humidities and loss in Haugh Units (Table 3) was only —0.049. The reason for this inconsistency was probably due to the variations in management and handling practices on these farms, differences in accompanying temperatures and the error introduced by taking only one humidity reading each month.

Although decline in albumen quality was apparently not related to humidity of the egg rooms, the percentage of Grade A eggs marketed

TABLE 3—The effect of relative humidity in egg room on egg quality decline

Season	High humidity		Medium humidity		Low humidity	
	Percent relative humidity	Decline in Haugh units	Percent relative humidity	Decline in Haugh units	Percent relative humidity	Decline in Haugh units
Fall	60	3.7	53	2.7	46	2.6
Winter	60	4.3	47	5.0	40	3.3
Spring	59	4.5	49	2.5	42	5.7
Summer	65	7.8	59	5.4	53	7.2

TABLE 4—Relationship between egg room relative humidity and percentage of Grade A eggs marketed

Season	Relative humidities*		
	High	Medium	Low
	Percent Grade A		
Fall	83.7	80.9	84.2
Winter	86.1	85.0	81.6
Spring	81.2	80.4	65.3
Summer	82.0	78.2	73.6

*Table 3 shows the average relative humidity in each group for each season.

was affected. Except for the fall months when little differences were noted between groups the percentage of Grade A eggs marketed was greater from the farms where highest humidities were maintained (Table 4). In the spring and summer months, these differences between farms with high and low humidities were 15.9 and 8.4 percent respectively. This indicates that either humidity affects candled quality more than albumen quality or it affects quality after the first 24 hours of holding more than during the early holding period.

DISCUSSION

The effects of temperature and humidity on egg quality cannot be considered separately since there is a joint correlation between them. This means that the relationship between loss in egg quality and humidity differs at different temperature levels. This fact was shown in Table 4 where quality (candled) was considerably lower in the low humidity group in the spring and summer than in the fall and winter when temperatures were lowest. Earle (1950) reported that humidity exerted the greatest influence on egg quality when temperatures in egg-holding rooms were relatively high.

Wilhelm (1939) reported that temperatures of 50°, 70°, and 90° F. were increasingly less desirable for the storage or holding of market eggs. He showed that egg quality decreased as much in 4 days at 70° F. as in 192 days at 30° F. The basement temperatures reported here were often over 70° F.

Van Wagenen, Hall and Altmann (1934) concluded that 45° F. was the most desirable temperature for holding eggs on the farm. "Sweating" occurred when eggs held at lower temperatures were removed to ordinary room temperatures for handling. Humidity of the room also affects this sweating.

Stadelman and Jensen (1951) reported that humidity was more important than temperature in maintaining candled grade, but temperature was most important in maintaining broken-out albumen quality. They found that humidity had little if any effect on the rate of loss of albumen index. Their results will substantiate, at least in part, the results of this experiment in which humidity seemed to have more effect on candled quality than on albumen quality.

Earle (1950) reported considerable differences in percentage of AA eggs at the farm between high- and low-temperature lots. However, in every month reported the low-temperature lots had consider-

ably higher humidities than the high-temperature lots, so it could have been humidity as well as temperature.

Lorenz and Newlon (1944) reported that cooling becomes more important the longer the eggs are to be held before delivery. This might account for the more pronounced and regular effect temperature had on candled quality than on albumen quality in this experiment.

A number of investigators have been unable to agree on the effect of humidity on the keeping quality of shell eggs. Van Wagenen, Hall and Altmann (1939), using observed score as their criterion, found that albumen quality declined more rapidly when relative humidity was 85 percent and least rapidly when it was 40 percent. Wilhelm (1939) found that albumen quality (albumen index) declined more rapidly at a relative humidity of 50 percent and least rapidly at a relative humidity of 90 percent. Jeffrey (1940) concluded that "decline in interior egg quality was regulated by temperature".

Earle (1950) concluded that humidity did not materially affect egg quality at low temperatures. However, in every month he showed higher temperatures in his low humidity lots than in his high humidity lots, hence introduced a bias in results.

It would seem from these reports that temperature has more influence than humidity on maintaining egg quality, particularly albumen quality of broken-out eggs. Humidity seems to have more influence on maintaining candled quality than albumen quality and has more influence at high than low temperatures. Hence, the optimum temperature and humidity for maintaining high candled egg quality may be quite different than those necessary for maintaining high quality in broken-out eggs.

SUMMARY AND INTERPRETATIONS

1. The temperatures and relative humidities of egg-holding rooms varied more from farm to farm within any month than from month to month. These variations were due to location of heating units in farm basements, location and insulation of egg holding rooms and possibly associated activities in the egg rooms such as, washing clothes or washing eggs. These activities affected temperatures and humidities on some farms during the time when records were obtained.

2. Egg room temperatures were consistently higher than outside temperatures, and relative humidities were consistently well below outside humidities. It probably would not be too difficult for most pro-

ducers to improve both temperature and humidity conditions in their egg rooms.

3. The average temperature for the year of 63° F. in egg-holding rooms and the summer temperature of 73° F. were well above recommended temperatures. Holding eggs at these high temperatures for several days resulted in a lower percentage of Grade A eggs marketed.

4. The initial loss in albumen quality (24 hours) was larger every season in the lots of eggs held at high temperatures. Correlation coefficient between temperature and decline in quality (Haugh units) was + 0.494.

5. The farmers who maintained highest egg-holding room temperatures marketed the lowest percentage of Grade A eggs every season.

6. The average relative humidity of all egg rooms for the year was 54 percent. The range between holding rooms was 34 percent in the winter months and 40 percent in the spring months. During other seasons this range was considerably less.

7. Relative humidity seemed to have little effect on albumen quality control during the first 24 hours. However, candled quality apparently was affected since a larger percentage of Grade A eggs were marketed from the farms where highest humidities were recorded.

8. Since there were apparent variations in the effect of temperature and humidity on maintainence of egg quality, and since previous investigators have not agreed on the effects of these factors, it is highly desirable that further controlled experiments be carried on to study the relationship between temperature, humidity and egg quality.

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A SIMPLIFIED MILL-STUDY METHOD FOR SMALL SAWMILLS

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OF THE MANY PROBLEMS in operating a sawmill, the determination of the "break-even" or marginal log is one of the most important. All sawmill operators know that they cannot realize a profit on every sawlog. They know, in general, that the small, defective logs and, possibly, the excessively large ones can be cut only at a loss, and that profit is derived from medium-diameter logs of the better grades. The difficulty encountered, however, is in giving a definite description of the "break-even" logs, i.e., the log which is on the dividing line between bringing a profit or a loss.

It would require a lengthy study at any sawmill to obtain complete information on the profit or loss to be derived from each log of each species and grade, for every market condition. Only a few large sawmills have the time or personnel to spare for such detailed mill studies. Small sawmill operators, however, cannot afford the cost of making detailed studies and rely entirely upon experience. It is the purpose of this report to show how a small operator may use his experience, together with a small amount of measuring, timing and computing, to determine whether a log is above or below marginal.

METHODS OF PROCEDURE

To demonstrate the procedures that a sawmill operator would follow, a study was conducted in a southern Michigan band mill. In this mill elm and hard maple are the principal species cut. Only the hard maple study, however, is included in this report.

In setting up a study of this character and in making use of information obtained, it must be remembered that species differ greatly in quality and value characteristics. It cannot be assumed, therefore, that within any species the yield will be the same for all logs within a size and quality class. Descriptions of a size or quality class must be

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made for each species on the basis of the average log for that species, and sufficient data must be taken to determine the class average.

For this type of study, experience must be relied upon to determine how far to extend measurements. To measure logs and record volume, value and time data for log sizes outside those in which the "break-even" logs are expected to fall, are unnecessary. Experience will indicate the range of size classes within this range, and only a sufficient number of classes outside this range should be included to establish curve trends.

It will be noted that no breakdown of log lengths was made. This does not mean that log values and logging and milling costs are not dependent upon log length. For purposes of this study, however, in which 93 logs were measured, the average lengths were so close to the average cut by the mill over a long period of time that the further breakdown into length classes would not have increased the accuracy to a sufficient degree to warrant the additional work.

THE USE OF LOG GRADES IN A MILL STUDY

The use of log grades is of great value in making the study and in the application of its results. A study without log-grade breakdown would only indicate the relative values of average logs in any species and size class, and would show only the average value of all logs cut by a mill. To calculate a true average would require a study of logs from many timber stands. On the other hand, the use of log grades permits one to assume that the average log in that grade of any species and size class cut at one time, will be very nearly the same as a corresponding log cut at any other time. The study can then be used as a basis for log-buying policies and cutting practices, regardless of whether the operator wishes to purchase logs by log grade.

For this study a modification of the log-grading system of the Northern Hardwood and Hemlock Manufacturers' Association (3) was used. That system gives results very nearly the same as those developed by the U. S. Forest Products Laboratory. These two systems give almost identical results and can be learned and applied in a very short time. The log-grading rules are shown in Table 1. Information needed for the study includes log values for different size classes and grades, based on market conditions, logging costs, and milling costs.

LOG VALUE

The log value represents the market value of all the lumber produced from the log. All values, as well as costs, are converted to a

TABLE 1—Hardwood log grades

Grade factors	No. 1 logs	No. 2 logs	No. 3 logs
Diameter (minimum).....	12″	12″	8″
Length (minimum).....	10′	10′	8′
Clear Cuttings (on best 3 faces)			
Length (minimum)...	5′	3′	no restrictions
No. per face (maximum).....	2	3	no restrictions
Yield in clear face (minimum).....	5/6 or 83%	2/3 or 67%	no restrictions
Sweep allowable	1″ in 4 ft.	1″ in 3 ft.	up to 50% of gross scale allowed for cull deduction
Cull deductions.....	None except where slight and within first foot of end of the log.	Cull allowed in inner 1/4 of dia. of log.	
Defects (shake, dote, wormholes, unsound heart, bird pecks, double heart and stains)	Not allowed except as above	Allowed as above	

Faces are determined by squaring the log with each of four faces considered separately. Clear cuttings are areas on each face that are free of visual defects such as knots. Grade of log is determined by lowest grade of three best faces.

one thousand board foot basis to standardize computation and comparison. Information required for the determination of value is recorded in the mill data form, Fig. 1.

Lgth.....12	Scale.....48	Time from:..10:20	Log No.....5
Dia.....12	Def.....	Time to:.....14:20	Spec.....H. M.
Grade.....2	Total.....48	Total:.....4:50	Date.....4-4-50

FAS			No. 1 and Sel.			No. 2			No. 3		
Th.	SM	BM	Th.	SM	BM	Th.	SM	BM	Th	SM	BM
5	6	8	4	3	3	5	7	9	4	6	6
4	6	8	4	6	6	4	6	6	4	6	6
			5	8	10				8	6	12
			4	5	5						
			4	4	4						
Total.....14			Total.....28			Total.....15			Total.....24		

Fig. 1. Mill data form. "Dia." is diameter measured to the nearest inch inside the bark at the small end of the log. "Th" is thickness in ¼ inches. "SM" is surface measure in sq. ft. "BM" is board measure in board feet. Lumber grades are "FAS" Firsts and Seconds; "No. 1 and Sel" are No. 1 common and selects; "No. 2" is No. 2 common, and "No. 3" is No. 3 common.

Logs were measured and graded on the log deck. Sawing time was recorded as the time from the dropping of one dog board until the dropping of the next. When sawing was interrupted, causing a delay in the sawing of a measured log, that log was omitted in working up the data. The reason for this is that the percentage of time loss for such a small number of logs can mean nothing. Delay must be accounted for, however, as will be shown later. Boards from each log were measured and graded after trimming, and the information recorded on the data card.

After all logs were sawn, the data cards were sorted by species, diameter and log grade. On each card the board measure was then found for each board, and the board measure columns for each lumber grade added vertically. Totals for each lumber grade for all cards in each log grade, species, and diameter group were then added together

TABLE 2—Log values by log grade and diameter class

Log grade	Diameter	No. of logs	Lumber Grade								Total volume	Total value	Value per M	Value 1M corrected for shrinkage and degrade. Col. 14 −10%
			F A S		No. 1 and Sel.		No. 2		No. 3					
			Volume mill tally	Value @ $190 per M	Volume mill tally	Value @ $125 per M	Volume mill tally	Value @ $78 per M	Volume mill tally	Value @ $58 per M				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	12	6	93	17.69	173	21.62	101	7.89	98	5.68	465	52.86	113.68	102.31
	13	6	153	29.07	220	27.50	121	9.44	114	6.61	608	72.62	119.44	107.50
	14	6	209	39.71	249	31.13	141	11.00	140	8.12	739	89.96	121.73	109.56
	15	4	161	30.59	172	21.50	94	7.33	78	4.52	505	63.94	126.61	113.95
	16	4	194	36.86	186	23.25	108	8.42	95	5.51	583	74.04	126.83	114.15
	17	4	236	44.84	224	28.00	123	9.59	92	5.34	685	87.77	128.13	115.32
2	12	4	22	4.18	96	12.00	86	6.71	115	6.67	319	29.56	92.66	83.40
	13	6	35	6.65	202	25.25	165	12.87	194	11.25	596	56.02	93.99	84.59
	14	5	43	8.17	210	26.25	163	12.71	184	10.67	600	57.80	98.00	88.20
	15	4	44	8.36	165	20.63	132	10.30	162	9.40	503	48.69	96.80	87.12
	16	5	73	13.87	248	31.00	184	14.35	237	13.75	742	72.97	98.34	88.51
	17	4	79	15.01	205	25.62	209	16.30	202	11.72	695	68.65	98.78	88.90
3	12	4	5	.95	30	3.75	112	8.73	161	9.34	308	22.77	73.93	66.54
	13	4	9	1.71	46	5.75	146	11.39	203	11.77	404	30.62	75.79	68.21
	14	5	19	3.61	75	9.38	184	14.35	306	17.75	584	45.09	77.21	69.49
	15	4	30	5.70	84	10.50	150	11.70	226	13.11	490	41.01	83.69	75.32
	16	4	26	4.94	89	11.13	163	12.71	301	17.46	579	46.24	79.86	71.87
	17	4	42	7.98	142	17.75	192	14.98	314	18.21	690	58.92	85.39	76.85

and recorded in columns 4, 6, 8 and 10 in Table 2. Columns 5, 7, 9 and 11 in Table 2 were found by multiplying volumes shown in columns 4, 6, 8 and 10 by the market price shown at the headings. These market prices are those given by the Hardwood Market Report (2) for Nov. 25, 1950, for 4/4 hard maple. Column 12 gives the sums of columns 4, 6, 8 and 10, added horizontally and column 13 gives sums of 5, 7, 9 and 11 added horizontally. Column 14 shows the value of the logs in each diameter class on a one thousand board foot basis, mill tally. Amounts are found by a simple proportion. For example, in Grade 1 logs in the 12-inch diameter class:

$$\frac{\text{Total log volume}}{1000 \text{ bd. ft.}} = \frac{\text{Total log value}}{X}$$

$$\frac{465}{1000} = \frac{53.86}{X}$$

$$465X = 52860.00$$

$$X = 113.68, \text{ the value per thousand board feet as shown in Col. 14}$$

In drying lumber there is considerable shrinkage and sometimes degrade. At the mill in which this study was conducted, shrinkage and degrade are estimated to be about 10 percent. Values in column 14 are therefore reduced by 10 percent to give values per thousand board feet corrected for shrinkage and degrade as shown in column 15. These are the values which will be used with costs to determine the "break-even" log.

COST AND PROFIT DETERMINATION

Cost of operating a sawmill includes buying and selling costs, labor, supervisory and clerical help, interest on indebtedness and capital, insurance, taxes and depreciation of equipment. For purposes of this study, costs are best considered in the following three groups: 1) logging, 2) milling, and 3) stumpage. Log buying will be included in stumpage. Logging costs will include felling and bucking, skidding, loading and hauling expenses as well as depreciation, interest, insurance, and taxes, applicable to those operations. Many mills contract this work on a thousand-board foot basis. When this is done, the costs

are lumped under logging. Milling costs include costs of handling the logs after they reach the mill, converting them into lumber, drying the lumber, and selling it, as well as the depreciation, interest, taxes, and insurance, which is applicable to these processes. Often log buying is charged with supervisory help in the cost of operating the sawmill. The two groups, logging and milling, can be considered as relatively constant for any size class or species in any one sawmill.

The third cost item, stumpage, will also remain relatively constant *as long as the market remains stable.* However, within the group, as stumpage prices rise, profit will necessarily fall, for profit presents only what remains over the stumpage price.

This type of study can show what the profit or loss will be for each diameter of log and grade at a given stumpage price. However, the results can best be used by the sawmill operator to show the total of stumpage and profit so that he can then make his own decision as to how he desires to divide it between those two items. The actual use of the information will be discussed later.

LOGGING COSTS

The mill in which the study was conducted contracts the logging on a 1000-board foot basis. For this study, the logging costs are taken to be as follows:

Felling and bucking	$ 7.00
Skidding	6.00
Loading and hauling	12.00
Total cost per M Doyle Scale	$25.00

These prices are paid regardless of the size of the logs. To find the price paid for logging, on a mill tally basis, the overrun percentage must be found for each diameter class and logging cost for each diameter size determined.

Overrun is the amount by which the actual log yield exceeds the volume, as measured by the Doyle log rule and expressed as a percentage of the Doyle rule volume. To find the overrun, the total mill tally and Doyle scale volumes for each diameter class and for all log grades combined were taken from the mill data cards. The totals by diameter classes were then recorded in Table 3.

TABLE 3—Overrun and logging cost by diameter classes

Dia.	No. of logs	Mill tally volume	Mill tally Vol. −10% for shrinkage end degrade	Doyle scale volume	Overrun Col. 4 minus Col. 5	Overrun % $\frac{\text{Col. 6}}{\text{Col. 5}} \times 100$	Corrected overrun (from Fig. 2)	Logging cost per M mill tally
1	2	3	4	5	6	7	8	9
12	14	1,092	938	666	317	47.6	47.5	16.93
13	16	1,508	1,357	1,001	356	35.6	38.7	18.45
14	16	1,923	1,731	1,300	431	33.2	31.4	19.03
15	12	1,498	1,348	1,070	278	26.0	26.0	19.84
16	13	1,904	1,714	1,443	271	18.8	21.4	20.59
17	12	2,070	1,863	1,570	293	18.7	17.5	21.28

The overrun was found as is shown in Table 3. The overrun percent, as indicated in column 7, was then plotted on Fig. 2 and a smooth curve drawn. The corrected overrun can be read as the point where the curve crosses the diameter ordinate. These values were recorded in column 8, Table 3.

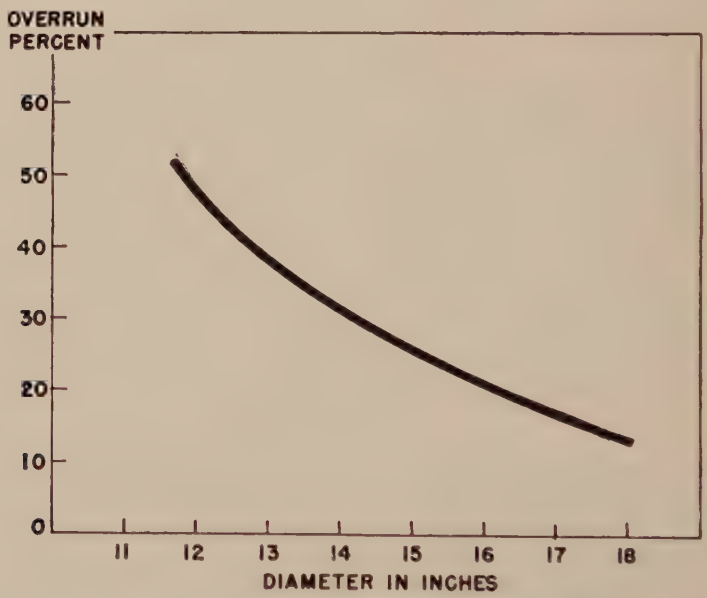

Fig. 2. Overrun percent by diameter classes.

Expressed as a percentage of Doyle scale, the mill tally volume would be equal to 100-percent of the Doyle scale volume, plus the overrun percent. For the 12-inch diameter class it would then be 147.7 percent. The logging cost per M mill tally is found by the proportion

of the total cost per M that the Doyle volume bears to the mill tally volume. For example, in the 12-inch diameter class, if X is the logging cost per M mill tally—

$$\frac{X \text{ (Logging cost/M mill tally)}}{\text{Logging cost per M (Doyle)}} = \frac{100}{147.7}$$

$$\frac{X}{25.00} = \frac{100}{147.7}$$

$$147.7X = 2500.00$$

$$X = 16.93 \text{ (The logging cost per M mill tally)}$$

Logging costs per M on a mill tally basis are recorded in column 9, Table 3 and will be used later.

MILLING COSTS

Milling costs per thousand board feet for each diameter class can most easily be found by determining the cost of one hour of operation and relating this cost to the number of board feet cut per hour in each diameter. The cost of an hour of operation can be found by taking costs from the company books for the previous year's operation and dividing by the number of hours the mill was in operation during this time.[1] For example, if the operating costs exclusive of stumpage and logging totaled $67,500 per year and the mill was in operation for

TABLE 4—Sawing volume per hour by diameter classes

Diameter	No. of logs	Mill tally volume	Sawing time, minutes	Volume per sawing hour	Corrected volume per sawing hour from Fig. 3	Volume per operating hour. Col. 6 −10%	Operating cost per M. B.M.
1	2	3	4	5	6	7	8
12	14	983	76.38	772.2	778	700	42.86
13	16	1,357	91.53	889.5	861	775	38.71
14	16	1,731	112.90	919.9	938	844	35.55
15	12	1,348	80.68	1,002.5	1,010	909	33.00
16	13	1,714	93.89	1,095.3	1,076	968	30.99
17	12	1,863	99.99	1,117.9	1,134	1,021	29.38

[1]Hourly costs must be taken from a normal operating year and may be assumed to be only approximate.

2,250 hours during the year, the operating cost per hour would be equal to

$$\frac{67{,}500}{2250} \text{ or } \$30.00 \text{ per hour}$$

Volume of cut per hour was taken from the mill data cards. All sawing times for each diameter class were totaled and recorded in Table 4. Mill tally volumes taken from column 4, Table 3 are also included in Table 4.

By proportioning data in columns 3 and 4, volume per sawing hour is found. This information is recorded in column 5, Table 4. For example, in the 12-inch diameter class:

$$\frac{\text{X (Vol./hour)}}{\text{Mill tally volume}} = \frac{\text{Minutes/hour}}{\text{Sawing time in minutes}}$$

$$\frac{X}{983} = \frac{60}{76.38}$$

$$76.38X = 58980$$

$$X = 772.2 \quad \text{Volume cut per hour of sawing time.}$$

Volumes in column 5 are then plotted (Fig. 3) and a curve drawn. Corrected volumes per sawing hour are then read from the curve and recorded in column 6. Records from previous studies of the mill show

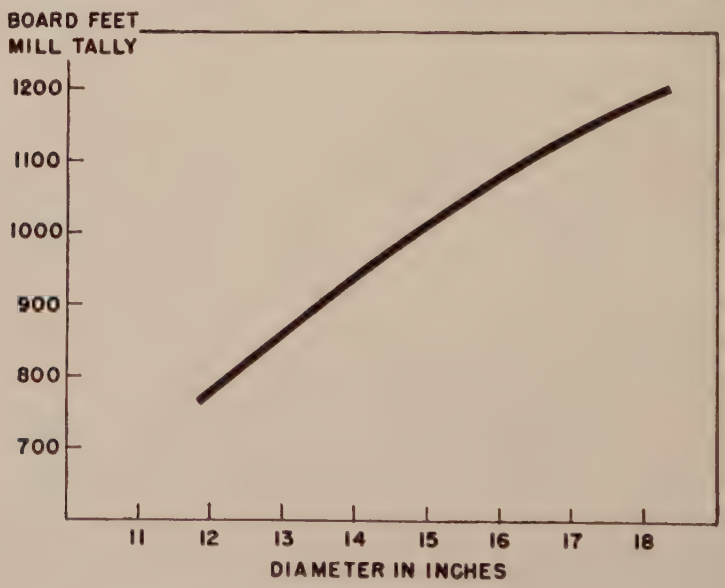

Fig. 3. Volume sawn per hour.

that total time lost to change saws, make repairs, etc., amounted to approximately 10 percent of the total time the mill was in operation. The volume cut per sawing hour must therefore be reduced by 10 percent to find the volume cut per hour the sawmill is in operation, column 7, Table 4.

The operating cost per thousand board feet in each diameter class can now be found by proportion from the volume cut per hour and the cost per hour of operation. In the 12-inch diameter class, if "X" is equal to the cost per M and the cost per hour is $30.00:

$$\frac{X \text{ (cost/M')}}{\text{Cost/hour}} = \frac{1000 \text{ b.m.}}{\text{Vol./operating hour}}$$

$$\frac{X}{30} = \frac{1000}{700}$$

$$700X = 30{,}000$$

$$X = \$42.86 \text{ the operating cost per M. B.M.}$$

The cost per thousand board feet is then recorded in Column 8, Table 4.

Data from Table 2, column 15; Table 3, column 9, and Table 4, column 8 may now be plotted, as shown in Fig. 4. Operating cost should be plotted above logging cost, however, in order that the sum of the two will appear on the graph. These costs are retabulated on Table 5 to facilitate plotting. Values may be plotted directly from Table 2.

TABLE 5—Operating costs

Diameter	No. of logs	Logging cost Table 3, Col. 9	Milling cost Table 4, Col. 8	Total cost logging plus milling
12	14	16.93	42.86	59.79
13	16	18.45	38.71	57.16
14	16	19.03	35.55	54.58
15	12	19.84	33.00	52.84
16	13	20.59	30.99	51.58
17	12	21.28	29.38	50.66

STUMPAGE

The cost of stumpage must be added to the logging and milling cost to determine the total cost exclusive of profit. Stumpage is vari-

able between logging tracts, so rather than set any fixed price, the cost of stumpage at different price levels will be plotted above logging and milling cost. Costs and values in Tables 2, 3 and 4 are given in terms of mill tally volumes. Therefore, the stumpage prices must be converted from a Doyle scale to mill tally basis. This is accomplished

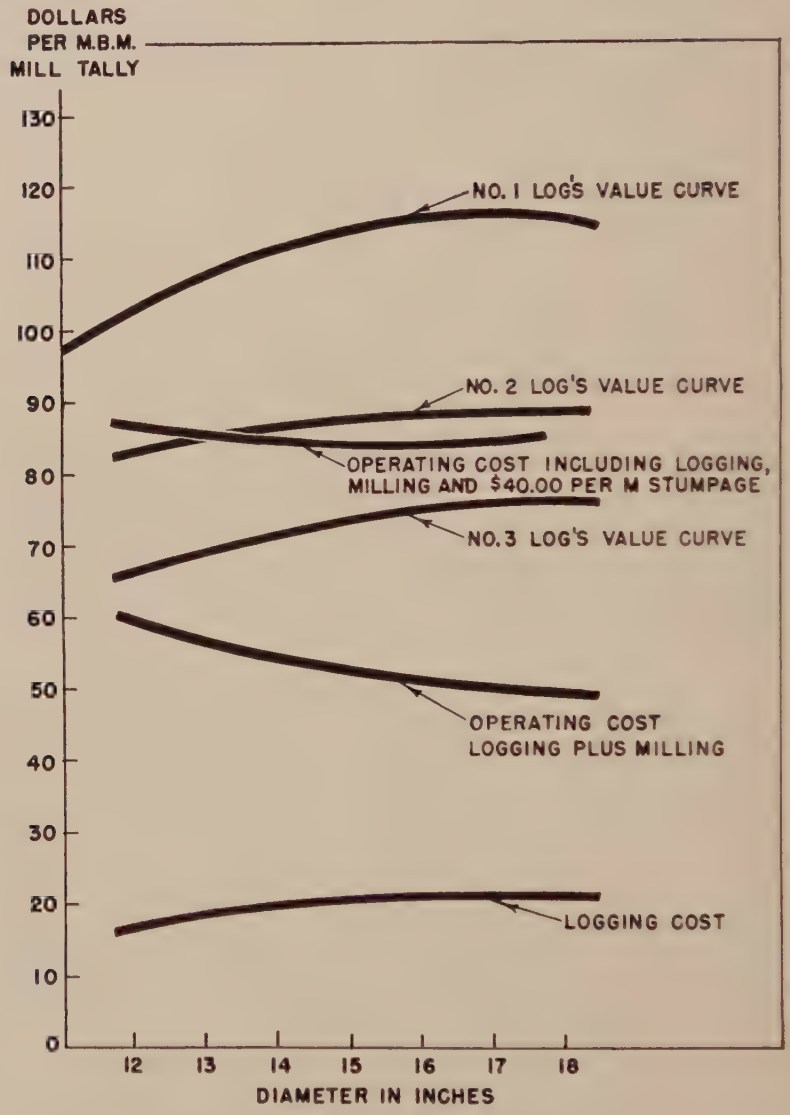

Fig. 4. Hard maple cost value chart.

as shown in the following example for the 12-inch diameter class, with stumpage value at $20.00 per thousand:

Doyle scale volume is taken at	1000 B.M.
Overrun (at 47.5%) volume	475
Expected mill tally volume	1475

If we let mill tally stumpage price equal "X", then by proportion:

$$\frac{\text{Stumpage price (Doyle)}}{\text{X (Stumpage price mill tally)}} = \frac{\text{1000 bd. ft.}}{\text{Expected mill volume}}$$

$$\frac{20}{X} = \frac{1475}{1000}$$

$$1475X = 20{,}000$$

$$X = \$13.56$$

The mill tally stumpage cost, if Doyle cost is $20.00/M and overrun is 47.5% in the 12″ diameter class.

The mill tally stumpage costs for different Doyle scale cost levels are shown in Table 6. These costs are then added to the logging and milling costs for each diameter class to find the total cost exclusive of profit.

TABLE 6—Mill tally stumpage cost and total operating cost

Log diameter, inches	Overrun		Doyle Scale cost per M						
			20.00	30.00	40.00	50.00	60.00	70.00	80.00
12	47.5	MTC*	13.56	20.34	27.12	33.90	40.68	47.46	54.24
		TOC*	73.35	80.13	86.91	93.69	100.47	107.25	114.03
13	38.7	MTC	14.51	21.63	28.84	36.05	43.26	50.47	57.68
		TOC	71.67	78.79	86.00	93.21	100.42	107.65	114.84
14	31.4	MTC	15.22	22.83	30.44	38.05	45.66	53.27	60.88
		TOC	69.80	77.41	85.02	92.63	100.24	107.85	115.46
15	26.0	MTC	15.87	23.81	31.75	39.68	47.62	55.56	63.49
		TOC	68.71	76.65	84.39	92.52	100.47	108.40	116.33
16	21.4	MTC	16.47	24.71	32.95	41.19	49.42	57.66	65.90
		TOC	68.05	76.29	84.53	92.77	101.00	109.24	117.48
17	17.5	MTC	17.02	25.53	34.04	42.55	51.06	59.57	68.08
		TOC	68.78	76.19	84.70	93.21	101.72	110.23	118.74

*MTC—Mill tally stumpage cost
*TOC—Total operating cost

Curves in Fig. 4 are drawn freehand, with the exception of the value curve for No. 1 logs. The equation for this curve is found to be:

$$y = -30.63 + 17.11X - 0.50X^2$$

Values for different diameter classes, as determined from this equation, are shown in Table 7 with the corresponding values from Table 2:

TABLE 7—Log values for No. 1 logs

Diameter	Value from Table 2	Value from equation $y = -30.63 + 17.11x - 0.50x^2$
11	.....	97.07
12	102.31	102.69
13	107.50	107.30
14	109.56	110.91
15	113.95	113.52
16	114.15	115.13
17	115.32	115.74
18	.....	115.35

COST VALUE CHARTS

Total operating costs from Table 6, at different stumpage levels, may then be plotted on the cost-value chart, Fig. 4. Only costs at the $40.00 per thousand stumpage price are shown, however, to indicate use of the table.

A curve connecting the points at the $40.00 M stumpage level crosses the value curve of the No. 2 logs at about 13½ inches. This indicates that the average log of No. 2 grade, 13½ inches in diameter, and at $40.00 M stumpage, is the "break-even" log from which the operator will derive neither profit nor loss. The operator will lose money on the average No. 2 log below 13½ inches in diameter and make money on those above it. Obviously, he will make money on all No. 1 logs at this stumpage price and will lose on all No. 3 logs.

Information in Fig. 4 may be used as a basis for stumpage price determination and as a guide for log buying and cutting practices. These uses are apparent. Two things must be taken into consideration, however. First, a No. 2 log is not necessarily the average of all logs in any one diameter class. For instance, in the 12-inch diameter class, the average log grade for all logs received at the mill will usually be between No. 2 and No. 3. Logs in the 18-inch diameter class, on the other hand, might well average above a No. 2 grade. This tendency of the small logs to be lower in value should encourage sawmill operators to make some valuation of log grade in buying timber. The second consideration is that even though a log is sub-marginal, or falls below

the cost line, it may pay the operator to process it and not leave it in the woods. If money has already been spent on the log in the way of stumpage, or felling and bucking, an operator might possibly avoid losing more money on the log by bringing it into the mill.

SUMMARY

Procedures used in this study indicate a simple method by which a small sawmill operator can determine which logs will yield a profit and which will not. Sequence of steps in the application of the method is as follows:

1. Grade and scale logs on the log deck.
2. Time the sawing operation for each log.
3. Grade and scale lumber from each log.
4. Compute values on a M.B.M. basis for each log diameter and grade in each species on the basis of market prices. Plot these values on a cost value chart.
5. Determine logging and milling costs on an M.B.M. basis and plot the total on the cost value chart.
6. Find log costs at different stumpage values and plot on cost value chart above total logging and milling cost.

The cost value chart thus obtained may then be used by the operator to determine the value of any log class at different stumpage prices. He can then use this information as a guide for log buying, logging, and milling practices.

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SOME OBSERVATIONS ON BACTERIAL-GROWTH ACTIVITY WHEN MILK COOLING IS DELAYED

By G. M. TROUT, A. L. BORTREE[1], *H. M. DALAYA*[2], *and P. S. MEDORA*[3]

DEPARTMENTS OF DAIRY AND BACTERIOLOGY AND PUBLIC HEALTH

FRESH RAW MILK seems to have a temporary inhibitory action on the growth of bacteria. Judged by the number of colonies that grow on agar, bacteria in freshly drawn milk remain inactive for a time. Even at favorable growth temperatures, they sometimes actually decrease in numbers. Then, after an apparent dormant period they begin to multiply rapidly, unless inhibited by adequate cooling. This seemingly phenomenal property of milk has long been known as the "germicidal action of milk." It may be due in part to the normal "lag phase," characteristic of bacterial growth in a new environment.

Research workers have made exhaustive studies on this phenomenon and have written much about its limitations and possibilities. Space here does not permit a thorough, comprehensive review of the literature on the subject. However, the excellent work and reviews on the "germicidal action of milk" by Hunziker (1901), Rosenau and McCoy (1909), Heineman (1921), Frayer (1932), Rogers (1945) and Hammer (1948) make possible a summary showing that the "germicidal action" of cow's milk

a) is apparent rather than real, the reduction in plate count of bacteria being due to clumping and to temporary dormancy rather than to actual dying off of the bacteria;

b) results from the influence of several factors such as the presence of antibodies, the phagocytic action of leucocytes, unsuitable environment, and the presence of lecithin thought to have a restraining action on bacteria;

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c) is specific, restraining certain organisms such as scarlet fever, typhoid, *Staphylococcus pyogenes aureus*, but not paratyphoid A and B and that various heat treatments make its action even more specific;

d) varies with different animals, between milkings and even among quarters of the same animal;

e) is entirely lost within a short time when the milk is kept warm (98.6° F.), lasts from 3 to 6 hours at 70° F., and is less pronounced, but of longer duration, at low temperature (40° F.);

f) is destroyed by pasteurization and boiling, but is not affected by freezing itself, unless the time factor is involved; and

g) is too feeble and variable at most to be of any practical value.

Despite the feeble, variable character of the slowing-up action of bacterial growth in fresh milk, it always operates in behalf of the milk producer, making possible some leniency in the time and rate of cooling milk. Perhaps a few dairymen take advantage of this phenomenon in delayed cooling, in slow cooling and/or in non-cooling of morning's milk where delivery of such milk is permitted. However, it would seem preferable to preserve the "germicidal action" of milk, if possible, by prompt, adequate cooling of the milk, rather than allowing it to dissipate itself needlessly through indifferent cooling procedures. By thus retaining the full bacterial-growth-retarding action of milk this bacteria-inhibiting power would be available to restrain bacterial growth in case the milk warmed up in transit or dumping was delayed at the receiving platform. Thus, the "germicidal action" of milk would be a tool which might serve the milk producer, if need be, after the milk had left the farm.

Studies on this phase of the delaying action of bacterial growth in milk are limited. Work along this line might reveal in part the reason why milks warmed in transit to the receiving station often vary so widely in bacteriological and organoleptical quality. Such data might give credence also to the postulation that the often observed differences in quality of the same-temperature milk at the receiving platform are due to the stage of preservation of the bacterial-retarding action of milk, weak as it may be. To this end the studies reported herein were made.

EXPERIMENTAL

Milk samples obtained by milking machine were poured into erlenmeyer flasks, placed in a thermos jug and taken directly to the laboratory. Portions of each sample were incubated at various temperatures and storage periods as the experiment dictated. Plate counts were made according to standard procedure. About 20 minutes elapsed between the time of milking and that of the first plating. The time of the first plating was recorded as the zero hour.

Influence of Temperature of Initial Cooling Upon Bacterial Growth When the Milk Was Warmed Later to a Favorable Growth Temperature—Milk cooled promptly to 40° F. and stored at that temperature for 10 hours retained in large part its bacterial retarding action, whereas this property was virtually gone in that milk cooled to and stored at 60° F. (Table 1). There was no evidence of a continued lag phase in bacterial

TABLE 1—Growth of bacteria in milk tempered to 70°F. when the milk had been cooled promptly after milking and had been stored at various temperatures (four trials)

Time (hours)	Bacteria count of milk which was held at 70°F. after previous cooling and 10-hour storage at		
	40°F.	60°F.	80°F.
After milking	*Cooled promptly and stored*		
0	31,000	31,000	31,000
10	30,000	150,000	180,000,000
After tempering	*Tempered to and held at 70°F.*		
2	36,000	160,000	3,600,000,000
4	77,000	2,500,000	?
8	600,000	45,000,000	Milk curdled
22	120,000,000	510,000,000	Milk curdled
34	Milk curdled	Milk curdled	Milk curdled

growth in that milk held at 80° F. At the end of the first 2-hour period following tempering of the milk to 70° F., the increase in bacteria count was approximately one, five and one-hundred and twenty-thousand fold in the samples which had been cooled and stored previously at 40°, 60° and 80° F., respectively. The marked geometric increase in bacteria count was just becoming evident after 4 hours at 70° F. in that milk which had been cooled promptly and held at 40° F.

Influence of a Delay in Cooling Milk Upon Later Bacterial Growth—The effect of delayed cooling of milk on bacterial growth is shown in

Tables 2 and 3. Evidence of the harmful effect of non-cooling in dissipating the bacterial-growth-inhibitory action of milk was not noted at the end of the 2-hour delay in cooling, but was to be seen soon afterwards when the milk was cooled to and stored at various temperatures (Table 2).

TABLE 2—Growth of bacteria in milk not cooled for 2 hours after milking (five trials)

Time after milking (hours)	Bacterial count of milk not cooled for 2 hours after milking but then cooled and stored at		
	40°F.	60°F.	80°F.
	Not cooled for 2 hours		
0	2,000	2,000	2,000
2	1,800	1,900	1,700
	Cooled and stored		
4	1,300	3,700	13,600
8	1,800	47,000	150,000
18	29,000	58,000	59,000,000
24	?	280,000	260,000,000
48	22,000	31,000,000	1,800,000,000
72	23,000	180,000,000	18,000,000,000
96	48,000	270,000,000	Milk curdled
120	65,000	1,100,000,000	Milk curdled

TABLE 3—Growth of bacteria in milk tempered to 70°F. when the milk had not been cooled promptly after milking but was finally cooled and stored at various temperatures (two trials)

Time (hours)	Bacteria count of milk which was held at 70°F. after a 2-hour delay in cooling and after a 10-hour storage at		
	40°F.	60°F.	80°F.
After milking	*Cooling delayed 2 hours, then cooled and stored*		
0	44,000	44,000	44,000
10	30,000	25,000	1,800,000
After tempering to 70°F.	*Tempered to and held at 70°F.*		
2	24,000	250,000	8,100,000
4	42,000	220,000	17,000,000
8	4,300,000	7,900,000	71,000,000
12	71,000,000	28,000,000	178,000,000
24	Milk curdled	Milk curdled	Milk curdled

When the delay-cooled, stored milk was tempered to 70° F., bacterial growth was restrained for 4 hours in that milk cooled to and stored at 40° F. but not in those milks cooled to and stored at 60° and 80° F. (Table 3).

DISCUSSION AND SUMMARY

The so-called "germicidal action" of fresh milk would seem to be of value only to those milk producers who follow good milk production practices in cooling the milk adequately and promptly after milking. This property of milk cannot be relied upon otherwise. Such cooled milk will maintain a low bacteria count for an extended storage. Furthermore, the preserved and thus prolonged "germicidal action" will restrain bacterial growth a reasonable length of time should the milk be warmed in transit.

When proper, adequate, electrical farm milk cooling is practiced the "germicidal property" of milk would seem to be of material aid in maintaining the good bacteriological and organoleptical quality of the milk. Often in this system of milk cooling, 2 hours elapse before the temperature of the milk is within safe limits so far as bacterial growth is concerned. In general, electric farm milk cooling merely involves setting filled, covered cans of freshly drawn milk into ice water, which extends up to the neck of the can. Here the milk is allowed to remain unstirred until the cans are removed by the hauler. An alternative method of mechanical refrigeration of milk incorporates spraying of the cans with ice water. Studies made by Anderson and Nicholas (1943) show that the temperature of milk was reduced below 60° F. within 2 hours when a 10-gallon can was set in water without agitation, either of the water or of the milk, but with a large amount of initially available refrigeration, with a heavy ice bank and with a water-to-milk ratio of 6:1. During this 2-hour cooling period bacterial growth was restrained and yet the bacterial delaying action of the milk was retained sufficiently to be of value, if need be, at a later period.

These trials support previous findings showing that the bacterial-growth-inhibiting property of fresh milk is soon dissipated unless the milk is promptly and adequately cooled; and that, when this property is preserved by adequate cooling, it may be of value in retarding bacterial growth should the milk be warmed subsequently to favorable growth temperatures. Thus, it is believed that the promptness and

adequacy of cooling milk account in large part for the differences often noted in the bacteriological and organoleptical quality of the same-temperature, warmed-in-transit milk at the receiving platform.

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JOURNAL ARTICLE ABSTRACTS

Influence of Environmental Temperatures and Thyroid Status on Sexual Development in Male Mouse

MAQSOOD, M. AND REINEKE, E. P.

Am. J. Physiology 162()1:24-30. 1950 (Journal Article 1069 from the Michigan Agricultural Experiment Station)

Groups of young male mice were rendered hypo- or hyperthyroid by feeding thiouracil or small amounts of synthetic thyroprotein, respectively. Similar treatment was given at environmental temperatures of 24 to 30°C. There was a significant increase in the weights of the testes and seminal vesicles of mice given 0.05 percent thyroprotein in the feed for a period of 4 weeks at 24°C., while higher doses caused a decrease in sex organ weights. Thyroprotein (0.005 percent) when fed to mice kept at 30° C. caused a significant increase in the weights of these organs when compared with the control at 30° C. High environmental temperature of 30° C. alone caused a decrease in the weights of testes and seminal vesicles. Administration of thiouracil (0.1 and 0.2 percent) in the feed caused a decrease in the weights of testes and seminal vesicles, which was more marked at the high environmental temperature. Histological studies showed that hyperthyroidism stimulated spermatogenic activity in the testes and caused proliferation of the mucosa of the seminal vesicles when compared with the control or hypothyroid male mouse. Hypothyroidism caused by the administration of thiouracil or exposure to high temperature resulted in atrophic and degenerative changes, with limited spermatogenesis.

The Effect of Three Methods of Watering on the Production of Carnations in Several Soils and Soil Mixtures

VAN LAAN, G. J. AND COOK, R. L.

Proc. Am. Soc. Hort. Sci. 56:415-422. 1950 (Journal Article 1089 from the Michigan Agricultural Experiment Station)

Carnations, grown in V-bottom concrete benches were watered in three ways: surface irrigation, sub-irrigation, and constant water level sub-irrigation. Under each method of watering were six soils and soil mixtures, ranging in texture from sand to clay loam. Soil mixtures were made by mixing two parts of soil with one of muck. Nutrient levels were uniformly maintained in all soils.

Soil moisture determinations showed that the quantity of available water in the soils increased with the clay content and that additions of muck to mineral soils caused still further increases.

Under surface watering, yields were not affected by soil type.

On all soils, sub-irrigation resulted in greater total plant growth and better quality blossoms than did surface watering.

Surface watering destroyed soil aggregation faster than did sub-irrigation.

Constant water level sub-irrigation resulted in the greatest yield, both of blossoms and total plants, on Brookston clay loam plus muck. Growth was very unsatisfactory with this method of watering on Oshtemo sand. Soil moisture and pore space measurements showed this to be due to excess water and the exclusion of air.

Judging only from this experiment one must conclude that constant water level sub-irrigation is desirable for carnations where the soil is clay loam but not where it is sand and that in either case results may be improved by mixing muck with the mineral soil.

Nutrient Levels for Flowering Crops

COOK, R. L.

Proc. Am. Soc. Hort. Sci. 56:446-456. 1950 (Journal Article 1098 from the Michigan Agricultural Experiment Station)

Calendula, forget-me-not, coleus, geranium, and cyclamen were grown in sandy soils containing all combinations of several levels of nitrate nitrogen, phosphorus, and potassium. Yield measurements and pictures show that these crops vary greatly in their response to various nutrient levels.

The results illustrate well the importance of proper balance among the various nutrients in the soil. The factorial nature of the experimental designs made it possible to show interactions between nutrients. With calendula, for instance, phosphorus had no effect on yields until nitrogen was applied. On the other hand, nitrogen caused some increase in growth without the application of phosphorus, but nitrogen response was much greater with phosphorus than without it. Similar interactions occurred with forget-me-not.

A presentation in tabular form shows the most favorable nutrient combinations for the five plants thus far studied. Experiments with other plants are in progress.

Plant Tissue Testing as a Guide to Side-Dressing Sugar Beets

ROBERTSON, L. S.

Proc. Amer. Soc. Sugar Beet Tech. February 6-10, 1950:348-352. 1950 (Journal Article 1119 from the Michigan Agricultural Experiment Station)

Rapid plant tissue tests can be made in the field to determine the nutrient status of a plant in regard to nitrogen, phosphorus and potassium. With the aid of these tests it is possible to determine with a reasonable degree of accuracy when a crop could use some supplemental plant food.

Plant tissue tests have been used on sugar beets, and where tests have been "high" throughout the growing season no response to side-dressing was indicated by sugar beet yields. On the other hand, when tissue tests were "low" or "blank" for a specific nutrient, side-dressing with the deficient nutrient has invariably increased sugar beet yields, provided all other growth factors affecting sugar beets were near optimum. Nitrogen, potassium, manganese, and boron have been side-dressed on sugar beets and the yields have been materially increased with, on the average, no decrease in sugar content.

A Biochemical and Bacteriological Study of Mare's Milk

DRURY, A. R., BRYAN, C. S., AND HUTTON, J. P.

Jour. Vet. Med. Assoc. 117(883):303-305. 1950 (Journal Article 1120 from the Michigan Agricultural Experiment Station)

The standard plate count of milk samples collected aseptically from 17 mares varied from 10 to 54,000. Of 33 samples collected, 22 had counts of less than 500, only two were higher than 10,000, while the remaining nine had counts varying from 500 to 10,000. In all but two mares, the counts of milk from each half were similar.

All 17 milk samples tested had less than 0.14 percent of chlorides, irrespective of whether streptococci were present. The pH of these samples was 6.6 except, in 4 cases where it was 6.7, 6.8, 7.3 and 7.4; an increase in the pH of milk was not associated with the presence of streptococci in the milk.

None of the 33 samples had more than 20,000 leucocytes per cubic centimeter of milk; all but four had counts of 10,000 or less.

The 10 representative organisms found in mare's milk belonged to the Micrococcus, Achromobacter, and Streptococcus genera.

Tillage Practices and Sugar Beet Yields

COOK, R. L.

Proc. Am. Soc. Sugar Beet Tech. 286-293. 1950 (Journal Article 1121 from the Michigan Agricultural Experiment Station)

Sugar beets, along with several other crops, were grown in a greenhouse in normally and excessively packed clay loam soil. Yields were depressed by the packing. Poor aeration in the packed soil was indicated by ferrous and ferric iron tests. Slow nitrification resulted from the poor aeration.

Additional nitrate fertilizer partially overcame the injury which resulted from excess packing.

Tillage experiments have shown that, after the moldboard plow, very little tillage is necessary for maximum yields of sugar beets. Furthermore the same experiments have failed to prove that any of the new methods of tillage are superior to those which include the use of the moldboard plow.

Soil Management Practices for Sugar Beets Grown on Organic Soils

DAVIS, J. F.

Proc. Am. Soc. Sug. Beet Tech. 1950:294-301. 1951 (Journal Article 1122 from the Michigan Agricultural Experiment Station)

In 1949 approximately 7,650 acres of beets were grown on the muck soils of Michigan, representing 10 percent of the total sugar beet acreage. With proper soil management practices, high yields of sugar beets can be grown on muck

soils. Included in the factors considered important is the maintenance of a water table at from 30 to 36 inches and adequate drainage. In order to maintain the desired height of water table, it may be necessary to incorporate dams or pumps in the drainage system.

Beets should be planted early, from May 5 to 25, and for each day's delay in planting, it is possible to experience as much as a daily reduction in yield of beets of a quarter of a ton.

Beets require a fertilizer high in potash. Five hundred pounds per acre of an 0-10-30 fertilizer has been found to be a good rate. Micro-nutrient elements are sometimes needed, and copper in the form of copper sulfate is added to the fertilizer mixture when the pH is 6.4 or below. Twenty-five to fifty pounds of copper sulfate per acre is recommended unless copper has been applied to the soil for previous crops. Boron in the form of borax is needed, and 15 to 20 pounds per acre is recommended for the acid mucks and 25 pounds per acre for the alkaline mucks. Manganese is effective if applied in the form of a spray and 500 pounds of salt is recommended, in addition to the fertilizer mixture. Drilling the fertilizer in 3½ inches deep with a grain drill is more efficient than broadcasting the fertilizer on the surface of the muck and disking in thoroughly. It is possible to lose a considerable amount of applied fertilizer through wind erosion.

Fertilizer placement does not seem to be too important, according to the data available, but possibly the residual effect of previous heavy fertilizer applications on the area on which the placement experiments were located is masking the effect of placement. Experiments are now in progress to eliminate this residual effect factor in the placement work.

The sugar content of the beets increased from September 6, 1949 to October 24, 1949 from 9.8 to 15.4 percent.

Lime is not recommended on muck soils for beets unless the pH is below 4.8. It is very important that soils be tested for pH at both the 0 to 6 inch layer and also at a depth of 2 feet in order to know whether or not an extremely acid layer of muck may exist in the sub-soil and thus, materially reduce the yield and produce a sprangly type of root.

Differentiation of Bacterial Species and Variations within the Species by Means of 2, 3, 5-Triphenyltetrazolium Chloride in Culture Medium

HUDDLESON, I. FOREST, AND BALTZER, BETTY

Science 112(2918):651-652. 1950 (Journal Article 1129 from the Michigan Agricultural Experiment Station)

A method is described for the differentiation of colonial forms and types of different bacteria by using 2, 3, 5-triphenyltetrazolium chloride in a suitable dilution in agar culture medium.

Colonies of different forms and types within a bacterial species develop different hues of red in the central area and a different delicate pastel hue in the border. Colonies of each different bacteria show a different color pattern, i.e. hues of red in the central area and lighter hues of either yellow, pink, or green in the border.

A Comparison of Tillage Implements

COOK, R. L., AND PEIKERT, F. W.

Agr'l Eng. 31(5):211-214. 1950 (Journal Article 1133 from the Michigan Agricultural Experiment Station)

Several types of tillage machines have been compared on three common Michigan soils. Corn, sugar beets, oats, sweet clover, alfalfa, and beans have been grown.

Rotary tillage was compared with normal tillage after the conventional plow and after the sub-base plow. An auger plow and a vertical disk plow were also included among the machines studied.

Over a 3-year period, no method of tillage has resulted in yields above those obtained when the moldboard plow was followed by conventional tillage.

The rotary tiller, the auger plow, and the vertical disk plow were not satisfactory where sweet clover or brome grass were growing.

Once-over soil preparation made possible by the plow-packer or mulcher attached directly to the conventional plow was found to be suitable for all of the crops included in the experiments.

Some Seed-Soil Moisture Studies with Sugar Beets

HUNTER, J. R., AND DEXTER, S. T.

Proc. Soc. of Sugar Beet Tech. 1950:270-274. 1951 (Journal Article 1139 from the Michigan Agricultural Experiment Station)

The rate of emergence of sugar beet seedlings is of great consequence to the sugar beet industry. These studies of seed, soil and air-moisture relationships are an attempt to establish a time schedule of water uptake and to determine the moisture factors responsible for tardy or rapid germination.

1. Seeds were exposed to atmospheres of various relative humidities and the rate of moisture uptake and final moisture equilibrium determined.

2. Seeds were mixed with soils of various moisture contents and rate of uptake of water, as well as final moisture content of seeds, determined.

3. Seeds were immersed in water, and rate of water uptake was determined.

4. Seeds of various moisture contents were mixed with soils of various moisture contents and the moisture uptake and rate of germination were determined.

   a) The effect of extra moisture added in contact with the seed was also determined.

Conclusions: 1. Seeds failed to germinate in air at 100 percent relative humidity. At this high humidity a maximum of 29 per cent moisture was absorbed after an interval of about 4 days.

2. In a Brookston clay loam germination did not occur unless the seed took up somewhat over 30 percent of moisture. Germination took 24 hours or more, but water absorption was complete in about 4 hours.

3. Seeds immersed in water took up over 30 percent of water in one half hour.

4. In soils near the lower critical moisture content for germination, planting seeds of higher moisture content speeded up emergence and adding small amounts of water in contact with the seed, induced germination even in soils drier than the critical point.

5. The moisture utilized to initiate germination seems to come from water films in the immediate vicinity of the seed. In soil near the wilting point, water available in films may be insufficient to bring the seed to the necessary moisture content of 32 percent.

The Effect of Antibiotics, Synthetic Vitamins, Vitamin B_{12} and an APF Supplement on Chick Growth

GROSCHKE, A. C., AND EVANS, R. J.

Poultry Sci. 29(4):616-618. 1950 (Journal Article 1145 from the Michigan Agricultural Experiment Station)

A commercial animal protein factor (APF) supplement (a *Streptomyces aureofaciens* fermentation product) promoted a greater growth response than crystalline B_{12} in depleted chicks fed an APF-deficient corn-soybean oil meal basal diet during a 2-week test period (2-4 weeks of age). Vitamin B_{12} with streptomycin or aureomycin, however, was equal to the APF supplement in stimulating growth. Best growth was obtained with a combination of B_{12} and synthetic vitamins (thiamine, Ca pantothenate, pyridoxine, folic acid, and biotin) with streptomycin or aureomycin. The possible mechanism of the growth effect from feeding antibiotics is discussed.

The Effect of the Length of Soak on the Quality of Canned and Frozen Montmorency Cherries

MARSHALL, R. E., ROBERTSON, W. F., BEDFORD, C. L., AND CASE, W. H.

Food Tech. 5(3):116-118. 1951 (Journal Article 1156 from the Michigan Agricultural Experiment Station)

The effect of the length of soak on the quality of canned and frozen Montmorency cherries was studied during 1949. The data obtained indicated that 12 hours was about the maximum length of soaking that could be used without resulting in considerable loss of fruit due to spoilage, loss of soluble solids, color, and increased toughness as measured by the tenderometer.

Soaking, as such, was not found essential to prevent tearing of the fruit during pitting or loss of juice since cherries cooled by either hydrocooling or refrigeration pitted as well as those soaked for 6 hours or more in tap water. Soaking does provide a convenient means of cooling and storing large volumes of fresh fruit.

No relationship was found between time of soak and the drained weight of the processed cherries.

Agriculture and the Conditions of Post-War Trading

WITT, LAWRENCE W.

Jour. Farm Economics 32(No. 4, Part 2):814-826. 1950 (Journal Article 1175 from the Michigan Agricultural Experiment Station)

This paper reviews developments in agriculture and international trade since 1945. Attention is directed to the implications of the Korean crisis on trade conditions. Three different assumptions are considered: 1) a return to the peace of May 1950; 2) full-scale warfare with the U.S.S.R. and 3) partial mobilization and heavy expenditures for military items.

Under the third and probably most realistic assumption, it is pointed out that inflation would be likely and that greater imports into the United States would occur as we sought raw materials and industrial goods to replenish our reduced supplies. Consequently, the exchange problem would probably be eased and agricultural exports could move more freely as European countries found it possible to reduce the stringency of trade controls. The competition for goods in the United States would reduce the level of living as war production expanded but increased imports from abroad could limit the decline, unless Europe itself became involved in heavy war activities.

Methods of Measuring Changes in Egg Quality in Terms of Physical Grade and Economic Value

LARZELERE, H. E., AND SHEPPARD, C. C.

Poultry Sci. 30(3):389-392. 1951 (Journal Article 1183 from the Michigan Agricultural Experiment Station)

The discussion involves the consideration of the advantages and limitations of several methods of measuring changes in egg quality: such as,

1) Difference in number of top grade eggs,
2) A measure in terms of the number of grade level declines,
3) A measure which provides an assigned digit (or weight) to each in accordance with average value relationships between grades, and
4) Actual changes in economic value of particular shipments of eggs.

Most of these methods either have been used in recent publications on changes in egg quality or are being contemplated for use in studies now in progress.

Surital Sodium: A New Anesthetic Agent for Intravenous Use

BRINKER, W. O., EADS, F. E., SALES, E. K., SCHIRMER, R. G., AND WHEELER, A. C.

Vet. Med. XLVI:31-32. No. 1, Jan. 51 (Journal Article 1190 from the Michigan Agricultural Experiment Station)

Surital sodium was used as an intravenous anesthetic in 180 canine and feline patients. They ranged from 5 weeks to 16 years of age and included all degrees of surgical and anesthetic risks. One death occurred.

Some of its advantages were found to be that the animal made little or no objection during the period of administration, those showing postoperative excitement being less than 5 percent. There was also an absence of emesis and post-

operative recovery started in an average of 10 to 20 minutes and was complete in one-half to one hour in most cases.

Some of its disadvantages were found to be that it stimulated the flow of saliva, muscular relaxation was not as complete as desired, and that it caused a local reaction to the point of sloughing if some was misplaced outside the vein.

Overall results indicate that if used with caution it is an anesthetic with a relatively high margin of safety and that it produces a minimum amount of circulatory and respiratory depression.

Effect of Vitamin B_{12} on Pantothenic Acid Metabolism in the Chick

EVANS, ROBERT JOHN, GROSCHKE, A. C., AND BUTTS, HELEN A.

Arch. Biochem. Biophys. 31(3):454-456. 1951 (Journal Article 1191 from the Michigan Agricultural Experiment Station)

Livers of growing chicks fed a basal corn-soybean diet deficient in vitamin B_{12} contained nearly three times as much pantothenic acid as livers of chicks fed the same basal diet supplemented with 30 μg. per kg. of vitamin B_{12}. The addition of streptomycin, a vitamin mixture composed of thiamine, calcium pantothenate, pyridoxine, folic acid, and biotin, or both had no influence on the results. Livers of chicks deficient in Vitamin B_{12} contained 144-158 μg. of pantothenic acid per gram, compared with 54-64 μg. per gram in livers of chicks receiving added vitamin B_{12}. The suggestion is made that vitamin B_{12} aids in the transfer of pantothenic acid from the liver for use elsewhere in the chick's body, and that in the absence of sufficient vitamin B_{12}, pantothenic acid accumulates in the liver.

The Growth Promoting Effects of Various Antibiotics on Pigs

LUECKE, R. W., THORP, F., JR., NEWLAND, H. W., AND MCMILLEN, W. N.

Jour. An. Sci. 10(2):538-542. 1951 (Journal Article 1195 from the Michigan Agricultural Experiment Station)

The inclusion of streptomycin at levels of 10 mg. per pound of feed in a corn-soybean and a mixed ration resulted in a small increase in growth of young pigs, but this increase was not statistically significant. However, the addition of liberal quantities of niacin, calcium pantothenate and riboflavin plus the streptomycin increased the growth rate on both rations significantly. Aureomycin, fed at levels of 10 mg. per pound and procaine penicillin fed at levels of 1 and 5 mg. per pound of feed were found to be considerably more effective than streptomycin. The data suggest that the growth promoting properties of certain antibiotics may be favorably influenced by fortification of rations with certain B-complex vitamins.

Structure and Sandy Soils

COOK, R. L.

Jour. Soil and Water Cons. 6(1):31-33, 42. 1951 (Journal Article 1198 from the Michigan Agricultural Experiment Station)

The use of green tissue tests in connection with fertilizer placement studies showed that Hillsdale sandy loam became so firmly packed by normal tillage and rainwater that corn roots were slow to reach plowed under fertilizer.

Fence row sandy loam, high in organic matter, did not pack. Cropped soil near by was very compact at the surface and at plow depth. It did not allow rapid water penetration as did the fence row soil.

Several soils in pots were puddled, then dried and tested with a penetrometer. A loam and two sandy soils were packed harder than was a virgin clay loam which contained 30-percent clay.

The Digestibility of Distillers Dried Solubles by Dairy Cattle

HUFFMAN, C. F., DUNCAN, C. W., AND BENNE, E. J.

Proc. Sixth Distillers Feed Conference 3-15-51. Cincinnati, Ohio, pp. 22-23. (Journal Article 1212 from the Michigan Agricultural Experiment Station)

Coefficients of digestibility of two types of Distillers Dried Solubles were determined when the dairy cow was used as the experimental animal. One of the Dried Solubles was derived from 67.5 percent corn, 20.5 percent rye and 12 percent malt and the other one was obtained from a 90 percent corn and 10 percent barley malt mash bill.

Four pregnant Holstein heifers and one Holstein cow were used to determine the coefficients of digestibility of the second cutting alfalfa hay used in the experimental work. Four of these cows were used to determine the coefficients of digestibility of the Distillers Dried Solubles. The preliminary feeding periods varied from 11 to 35 days and 10-day collection periods were made when the Solubles were fed. The dry matter intake remained constant for each cow throughout the various digestion trials.

The average coefficients of digestibility obtained for Distillers Dried Solubles No. 1 were: dry matter 78, protein 74, ether extract 64, crude fiber 63, and nitrogen-free extract 88. The percentages determined for digestible protein and T.D.N. were 20.11 and 76.9 respectively.

The coefficients of digestibility obtained for Distillers Dried Solubles No. 2 were: dry matter 89, protein 83, ether extract 79, crude fiber 86, and nitrogen-free extract 94. The percentages determined for digestible protein and T.D.N. were 28.93 and 89.9, respectively.

Effect of Derivatives of L-Cysteine on the Growth of *Leuconostoc mesenteroides* P-60

WELLER, LOWELL, E., LUECKE, RICHARD W., AND SELL, HAROLD M.

Proc. Soc. Exptl. Biol. and Med. 77:3-5. 1951 (Journal Article 1213 from the Michigan Agricultural Experiment Station)

Alliin (S-allyl-L-cysteine sulfoxide) and L-cystine disulfoxide stimulated the growth of *Leuconostoc mesenteroides* P-60 but to a lesser degree than L-cysteine. Substitution of the sulfur hydrogen of L-cysteine by alkyl and alkene radicals did not produce any observable response. The sulfoxide of S-ethyl-L-cysteine was also inactive; however, S-propyl-L-cysteine sulfoxide was found to have a very slight activity. The activity of alliin may be due to both the presence of the sulfoxide group and the unsaturation in the alkyl radical.

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